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Also of interest to the following committees Intéresse également les comités suivants	Supersedes document Remplace le document 80/203/CDV - 80/232/RVC

Horizontal functions concerned
Fonctions horizontales concernées

☐ Safety Sécurité	☐ EMC CEM	☐ Environment Environnement	☐ Quality assurance Assurance de la qualité

INTERNATIONAL ELECTROTECHNICAL COMMISSION — COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

Title

Draft IEC 61162-1, Ed. 2: Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners

Titre

ATTENTION
VOTE PARALLÈLE
CEI – CENELEC

L'attention des Comités nationaux de la CEI, membres du CENELEC, est attirée sur le fait que ce projet final de Norme internationale est soumis au vote parallèle. Un bulletin de vote séparé pour le vote CENELEC leur sera envoyé par le Secrétariat Central du CENELEC.

ATTENTION
IEC – CENELEC
PARALLEL VOTING

The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this final Draft International Standard (DIS) is submitted for parallel voting. A separate form for CENELEC voting will be sent to them by the CENELEC Central Secretariat.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR APPROVAL. IT MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, FINAL DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

CE DOCUMENT EST UN PROJET DIFFUSÉ POUR APPROBATION. IL NE PEUT ÊTRE CITÉ COMME NORME INTERNATIONALE AVANT SA PUBLICATION EN TANT QUE TELLE.

OUTRE LE FAIT D'ÊTRE EXAMINÉS POUR ÉTABLIR S'ILS SONT ACCEPTABLES À DES FINS INDUSTRIELLES, TECHNOLOGIQUES ET COMMERCIALES, AINSI QUE DU POINT DE VUE DES UTILISATEURS, LES PROJETS FINAUX DE NORMES INTERNATIONALES DOIVENT PARFOIS ÊTRE EXAMINÉS EN VUE DE LEUR POSSIBILITÉ DE DEVENIR DES NORMES POUVANT SERVIR DE RÉFÉRENCE DANS LES RÈGLEMENTATIONS NATIONALES.

FORM 9 (IEC)/FORMULAIRE 9 (CEI)
1999-10-01

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 1: Single talker and multiple listeners

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61162-1 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

This second edition cancels and replaces the first edition published in 1995, and constitutes a technical revision. This part of IEC 61162 is closely aligned with NMEA 0183 version 2.30.

The text of this standard is based on

FDIS	Report on voting
80/XXX/FDIS	80/XXX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annex C forms an integral part of this standard.

Annexes A and B are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

IEC TC 80 interface standards are developed with input from manufacturers, private and government organisations and equipment operators. The information contained in this standard is intended to meet the needs of users at the time of publication, but users must recognise that as applications and technology change, interface standards must change as well. Users of this document are advised to immediately inform the IEC of any perceived inadequacies in this standard.

The following notes provide the background to changes introduced to the first edition of this standard.

NOTE 1 The sentences in IEC 61162-1:1995-11 which were indicated as "(to be further developed)" have now been developed. The sentences involved are:

DSC – Digital selective calling (DSC) (see also DSE, DSI and DSR)

DTM – Datum reference

ASD – Autopilot system data has been deleted and renamed in line with IMO definitions – see HTC and HTD below.

NOTE 2 New sentences have been added:

ACK Acknowledge alarm
ALR Set alarm state
DSE Expanded digital selective calling
DSI DSC transponder initiate
DSR DSC transponder response
GNS GNSS fix data
HMS Heading monitor set
HMR Heading monitor receive
HTC Heading/track control command
HTD Heading/track control data
MLA GLONASS almanac data
MWD Wind direction and speed
TLB Target label
TXT Text transmission

NOTE 3 The following sentences have been deleted, as the systems referred to are no longer in operation:

GXA – TRANSIT position, OLN – OMEGA lane numbers, TRF – TRANSIT fix data.

NOTE 4 Detailed modifications have been made to the following sentences**:**

FSI, GBS, GGA, GRS, MSK, MSS, OSD, RMA, RMB, RMC, SFI, TLL, TTM, VBW, XDR and ZDA.

Details of the changes are given in the relevant pages.

NOTE 5 A mode indicator character field "a" has been added as a new last data field to specific sentences, namely APB, BWC, BWR, GLL, RMA, RMB, RMC, VTG, WCV and XTE.

The mode indicator character "a" has been defined to include the following when used in the designated sentences:

A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual input mode
S = Simulator mode
N = Data not valid

NOTE 6 A note has been added to sentences APB, GLL, RMA, RMB, RMC and XTE (which contain a status field "A") as follows:

"Note: the mode indicator field supplements the status field (field n), the status field shall be set to V = Invalid for all values of mode indicator except for A = Autonomous and D = Differential."

NOTE 7 A note has been added to all appropriate sentences to state that "the quality indicator, mode indicator, operating mode and status fields shall not be null fields."

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 1: Single talker and multiple listeners

1 General

1.1 Scope

This part of IEC 61162 contains the requirements for data communication between maritime electronic instruments, navigation and radiocommunication equipment when interconnected via an appropriate system.

This standard is intended to support one-way serial data transmission from a single talker to one or more listeners. This data is in printable ASCII form and may include information such as position, speed, depth, frequency allocation, etc. Typical messages may be from about 20 to a maximum of 79 characters in length and generally require transmission no more rapidly than one message per second.

The electrical definitions in this standard are not intended to accommodate high-bandwidth applications such as radar or video imagery, or intensive database or file transfer applications. Since there is no provision for guaranteed delivery of messages and only limited error checking capability, this standard should be used with caution in all safety applications.

For applications where a faster transmission rate is necessary, reference should be made to IEC 61162-2.

Annex A contains a list of relevant International Maritime Organization (IMO) resolutions and International Telecommunication Union (ITU) recommendations to which this standard applies.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61162. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61162 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 61162-2:1998, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 2: Single talker and multiple listeners, high-speed transmission*

ISO/IEC 8859-1:1998, *Information technology – 8-bit single-byte coded graphic character sets – Part 1: Latin alphabet No.1*

ITU-R M.493-9:1997, *Digital selective-calling system for use in the maritime mobile service*

ITU-R M.821-1:1997, *Optional expansion of the digital selective-calling system for use in the maritime mobile service*

ITU-R M.825-3:1998, *Characteristics of a transponder system using digital selective calling techniques for use with vessel traffic services and ship-to-ship identification*

ITU-T X.27/V.11:1996, *Electrical characteristics for balanced double-current interchange circuits operating at data signalling rates up to 10 Mbit/s*

NMEA 0183:1998, *National Marine Electronics Association (USA) – Standard for interfacing marine electronic devices, version 2.30*

RTCM:1998, *RTCM (Radio Technical Commission for Maritime Services) SC-104 Recommended standards for differential GNSS (Global Navigation Satellite Systems) service, version 2.2*

IHO:1994, *Special publication No. 60*, *User's handbook on datum transformations involving WGS 84*

GLONASS:1995, *Interface control document*

Rockwell International Corporation ICD-GPS-200:1987, *Interface control document*, *Navstar GPS space segment/navigation user interface*

1.3 Definitions

Common terms are defined in the glossary of annex B. Where there is a conflict, terms shall be interpreted wherever possible in accordance with the references in 1.2.

For the purposes of this part of IEC 61162, the following definitions apply.

talker
any device which sends data to other devices. The type of talker is identified by a 2-character mnemonic as listed in 6.2 (Table 4)

listener
any device which receives data from another device

2 Manufacturer's documentation

Operator manuals or other appropriate literature provided for equipment that is intended to meet the requirements of this standard shall contain the following information:

a) identification of the A and B signal lines;
b) the output drive capability as a talker;
c) a list of approved sentences, noting unused fields, proprietary sentences transmitted as a talker and transmission interval for each sentence;
d) the load requirements as a listener;
e) a list of sentences and associated data fields that are required as a listener;
f) the current software and hardware revision if this is relevant to the interface;
g) an electrical description or schematic of the listener/talker input/output circuits citing actual components and devices used, including connector type and part number;
h) the version number and date of update of the standard for which compliance is sought.

3 Hardware specification

One talker and multiple listeners may be connected in parallel over an interconnecting wire. The number of listeners depends on the output capability and input drive requirements of individual devices.

3.1 Interconnecting wire

Interconnection between devices may be by means of a two-conductor, shielded, twisted-pair wire.

3.2 Conductor definitions

The conductors referred to in this standard are the signal lines A and B, and shield.

3.3 Electrical connections/shield requirements

All signal line A connections are connected in parallel with all device A connections and all signal line B connections are connected in parallel with all device B connections. The shields of all listener cables should be connected to the talker chassis only and should not be connected at each listener.

3.4 Connector

No standard connector is specified. Wherever possible readily available commercial connectors shall be used. Manufacturers shall provide means for user identification of the connections used.

3.5 Electrical signal characteristics

This subclause describes the electrical characteristics of transmitters and receivers.

3.5.1 Signal state definitions

The idle, marking, logical 1, OFF or stop bit states are defined by a negative voltage on line A with respect to line B.

The active, spacing, logical 0, ON or start bit states are defined by a positive voltage on line A with respect to line B.

It should be noted that the above A with respect to B levels are inverted from the voltage input/output requirements of standard UARTs and that many line drivers and receivers provide a logic inversion.

3.5.2 Talker drive circuits

No provision is made for more than a single talker to be connected to the bus. The drive circuit used to provide the signal A and the return B shall meet, as a minimum, the requirements of ITU-T X.27/V.11.

3.5.3 Listener receive circuits

Multiple listeners may be connected to a single talker. The listener receive circuit shall consist of an opto-isolator and shall have protective circuits to limit current, reverse bias and power dissipation at the opto-diode as shown in figure 1. Reference is made to example circuits in 7.2.

The receive circuit shall be designed for operation with a minimum differential input voltage of 2,0 V [1)] and shall not take more than 2,0 mA from the line at that voltage.

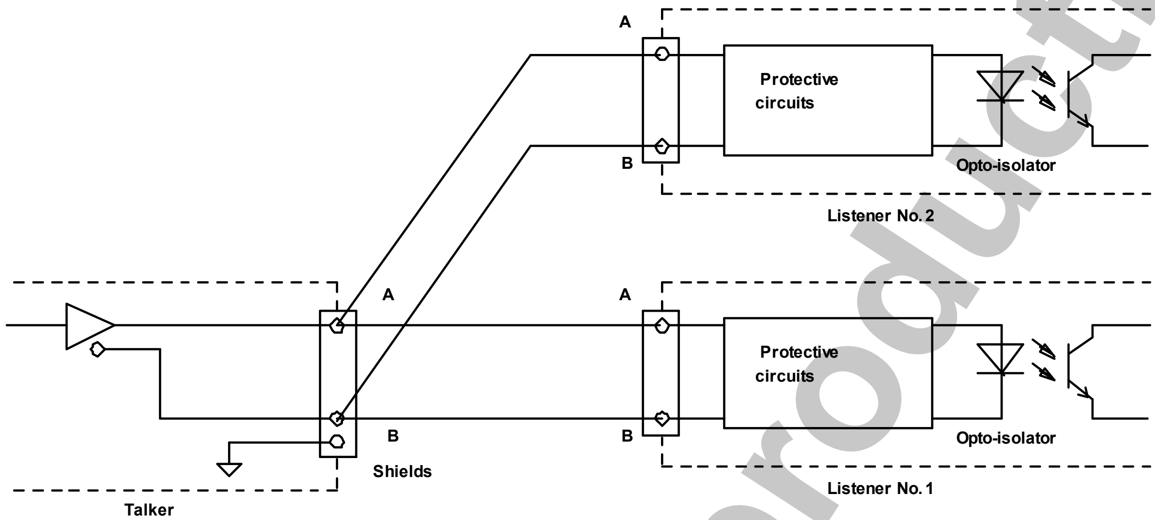

Figure 1 – Listener receive circuit

3.5.4 Electrical isolation

Within a listener there shall be no direct electrical connection between the signal line A, return line B, or shield and ships' ground or power. Isolation from ships' ground is required.

3.5.5 Maximum voltage on bus

The maximum applied voltage between signal lines A and B and between either line and ground shall be in accordance with ITU-T X.27/V.11.

For protection against mis-wiring and for use with earlier talker designs, all receive circuit devices shall be capable of withstanding 15 V between signal lines A and B and between either line and ground for an indefinite period.

4 Data transmission

Data is transmitted in serial asynchronous form in accordance with the standards referenced in 2.1. The first bit is a start bit and is followed by data bits, least-significant-bit first, as illustrated by figure 2.

The following parameters are used:

– baud rate 4 800;
– data bits 8 (D7 = 0), parity none;
– stop bits 1.

[1)] For reasons of compatibility with equipment designed to comply with earlier versions of NMEA 0183, it is noted that the idle, marking, logical "1", OFF or stop bit state had previously been defined to be in the range –15,0 V to +0,5 V. The active, spacing, logical "0", ON or start bit state was defined to be in the range +4,0 V to +15,0 V while sourcing was not less than 15 mA.

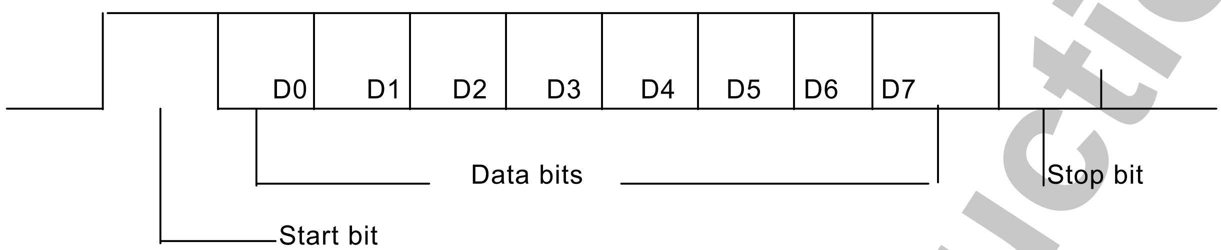

Figure 2 – Data transmission format

5 Data format protocol

5.1 Characters

All transmitted data shall be interpreted as ASCII characters. The most significant bit of the eight-bit character shall always be transmitted as zero (D7 = 0).

5.1.1 Reserved characters

The reserved character set consists of those ASCII characters shown in 6.1 (Table 1). These characters are used for specific formatting purposes, such as sentence and field delimiting, and except for code delimiting, shall not be used in data fields.

5.1.2 Valid characters

The valid character set consists of all printable ASCII characters (HEX 20 to HEX 7E) except those defined as reserved characters. The list of the valid character set is given in 6.1 (Table 2).

5.1.3 Undefined characters

ASCII values not specified as either “reserved characters” or “valid characters” are excluded and shall not be transmitted at any time.

When it is necessary to communicate an 8-bit character defined by ISO/IEC 8859-1 that is a reserved character (Table 1) or not listed in Table 2 as a valid character (e.g. in a proprietary sentence or text sentence), three characters shall be used.

The reserved character “^“ (HEX 5E) is followed by two ASCII characters (0-9, A-F) representing the HEX value of the character to be communicated. For example:

– to send heading as "127.5°", transmit “127.5 ^F8”;
– to send the reserved characters <CR><LF>, transmit “^0D^0A”;
– to send the reserved character "^", transmit “^5E”.

5.1.4 Character symbols

When individual characters are used in this standard to define units of measurement, to indicate the type of data field, type of sentence, etc. they shall be interpreted according to the character symbol in 6.1 (Table 3).

5.2 Fields

A field consists of a string of valid characters, or no characters (null field), located between two appropriate delimiter characters.

5.2.1 Address field

An address field is the first field in a sentence and follows the "$" delimiter; it serves to define the sentence. Characters within the address field are limited to digits and upper case letters. The address field shall not be a null field. Only sentences with the following three types of address fields shall be transmitted.

5.2.1.1 Approved address field

Approved address fields consist of five characters defined by this standard. The first two characters are the talker identifier, listed in 6.2 (Table 4). The talker identifier serves to define the nature of the data being transmitted.

Devices that have the capability to transmit data from multiple sources shall transmit the appropriate talker identifier (e.g., a device with both a GPS receiver and a Loran-C receiver shall transmit GP when the position is GPS-based, LC when the position is Loran-C-based, and IN for integrated navigation shall be used if lines of position from Loran-C and GPS are combined into a position fix).

Devices capable of re-transmitting data from other sources shall use the appropriate identifier (e.g. GPS receivers transmitting heading data shall not transmit $GPHCD unless the compass heading is actually derived from the GPS signals).

The next three characters form the sentence formatter used to define the format and the type of data. A list of approved sentence formatters is given in 6.2 (Table 5).

5.2.1.2 Query address field

The query address field consists of five characters and is used for the purpose of requesting transmission of a specific sentence on a separate bus from an identified talker.

The first two characters are the talker identifier of the device requesting data, the next two characters are the talker identifier of the device being addressed and the final character is the query character Q.

5.2.1.3 Proprietary address field

The proprietary address field consists of the proprietary character P followed by a three-character manufacturer's mnemonic code, used to identify the talker issuing a proprietary sentence, and any additional characters as required. A list of valid manufacturer's mnemonic codes may be obtained from NMEA (see 5.3.3).

5.2.2 Data fields

Data fields in approved sentences follow a "," delimiter and contain valid characters (and code delimiters “^”) in accordance with the formats illustrated in 6.2 (Table 6). Data fields in proprietary sentences contain only valid characters and the delimiter characters “,” and “^”, but are not defined by this standard.

Because of the presence of variable data fields and null fields, specific data fields shall only be located within a sentence by observing the field delimiters ",". Therefore, it is essential for the listener to locate fields by counting delimiters rather than counting the total number of characters received from the start of the sentence.

5.2.2.1 Variable length fields

Although some data fields are defined to have fixed length, many are of variable length in order to allow devices to convey information and to provide data with more or less precision, according to the capability or requirements of a particular device.

Variable length fields may be alphanumeric or numeric fields. Variable numeric fields may contain a decimal point and may contain leading or trailing zeros.

5.2.2.2 Data field types

Data fields may be alpha, numeric, alphanumeric, variable length, fixed length or fixed/ variable (with a portion fixed in length while the remainder varies). Some fields are constant, with their value dictated by a specific sentence definition. The allowable field types are summarized in 6.2 (Table 6).

5.2.2.3 Null fields

A null field is a field of length zero, i.e. no characters are transmitted in the field. Null fields shall be used when the value is unreliable or not available.

For example, if heading information were not available, sending data of "000" is misleading because a user cannot distinguish between "000" meaning no data and a legitimate heading of "000". However, a null field, with no characters at all, clearly indicates that no data is being transmitted.

Null fields with their delimiters can have the following appearance depending on where they are located in the sentence:

",," ",*"

The ASCII NULL character (HEX 00) shall not be used as the null field.

5.2.3 Checksum field

A checksum field shall be transmitted in all sentences. The checksum field is the last field in a sentence and follows the checksum delimiter character "*". The checksum is the eight-bit exclusive OR (no start or stop bits) of all characters in the sentence, including "," delimiters, between but not including the "$" and the "*" delimiters.

The hexadecimal value of the most significant and least significant four bits of the result is converted to two ASCII characters (0-9, A-F) for transmission. The most significant character is transmitted first.

Examples of the checksum field are:

$GPGLL,5057.970,N,00146.110,E,142451,A*27 and

$GPVTG,089.0,T,,,15.2,N,,*7F .

5.3 Sentences

This subclause describes the general structure of sentences. Details of specific sentence formats are found in 6.3. Some sentences may specify restrictions beyond the general limitations given in this part of this standard. Such restrictions may include defining some fields as fixed length, numeric or text only, required to be non-null, transmitted with a certain frequency, etc.

The maximum number of characters in a sentence shall be 82, consisting of a maximum of 79 characters between the starting delimiter "$" and the terminating delimiter <CR><LF>.

The minimum number of fields in a sentence is one (1). The first field shall be an address field containing the identity of the talker and the sentence formatter which specifies the number of data fields in the sentence, the type of data they contain and the order in which the data fields are transmitted. The remaining portion of the sentence may contain zero or multiple data fields.

The maximum number of fields allowed in a single sentence is limited only by the maximum sentence length of 82 characters. Null fields may be present in the sentence and shall always be used if data for that field is unavailable.

All sentences begin with the sentence-starting delimiter character "$" and end with the sentence-terminating delimiter <CR><LF>.

5.3.1 Description of approved sentences

Approved sentences are those designed for general use and detailed in this standard. Approved sentences are listed in 6.3 and shall be used wherever possible. Other sentences, not recommended for new designs, may be found in practice. Such sentences are listed in NMEA 0183. Information on such sentences may be obtained from the National Marine Electronics Association (NMEA)(USA).

An approved sentence contains, in the order shown, the following elements:

ASCII	HEX	Description
"$"	24	– start of sentence
<address field>		– talker identifier and sentence formatter
["," <data field>]		– zero or more data fields
["," <data field>]		
"*" <checksum field>		– checksum field
<CR><LF>	0D 0A	– end of sentence

5.3.1.1 Approval sentence structure

The following provides a summary explanation of the approved sentence structure:

$aaccc, c---c*hh<CR><LF>

ASCII	HEX	Description
"$"	24	Start of sentence: starting delimiter
aaccc		Address field: alphanumeric characters identifying type of talker, and sentence formatter. The first two characters identify the talker. The last three are the sentence formatter mnemonic code identifying the data type and the string format of the successive fields. Mnemonics will be used as far as possible to facilitate read-outs by users.
","	2C	Field delimiter: starts each field except address and checksum fields. If it is followed by a null field, it is all that remains to indicate no data in a field.

c---c		Data sentence block: follows address field and is a series of data fields containing all of the data to be transmitted. Data field sequence is fixed and identified by the third and subsequent characters of the address field (the sentence formatter). Data fields may be of variable length and are preceded by delimiters ",".
"*"	2A	checksum delimiter: follows last data field of the sentence. It indicates that the following two alpha-numeric characters show the HEX value of the checksum.
hh		Checksum field: the absolute value calculated by exclusive-OR'ing the eight data bits (no start bits or stop bits) of each character in the sentence between, but excluding, "$" and "*". The hexadecimal value of the most significant and least significant four bits of the result are converted to two ASCII characters (0-9, A-F) for transmission. The most significant character is transmitted first. The checksum field is required in all cases.
<CR><LF>	0D 0A	End of sentence: sentence terminating delimiter.

5.3.2 Query sentences

Query sentences are intended to request approved sentences to be transmitted in a form of two-way communication. The use of query sentences implies that the listener shall have the capability of being a talker with its own bus.

The approved query sentence contains, in the order shown, the following elements:

ASCII	HEX	Description
"$"	24	start of sentence
<aa>		talker identifier of requester
<aa>		talker identifier for device from which data is being requested
"Q"		query character, identifies query address
","		data field delimiter
<ccc>		approved sentence formatter of data being requested
"*"	<checksum field>	checksum field
<CR><LF>	0D 0A	end of sentence

5.3.2.1 Reply to query sentence

The reply to a query sentence is the approved sentence that was requested. The use of query sentences requires cooperation between the devices that are interconnected. A reply to a query sentence is not mandatory and there is no specified time delay between the receipt of a query and the reply.

5.3.3 Proprietary sentences

These are sentences not included within this standard; these provide a means for manufacturers to use the sentence structure definitions of this standard to transfer data which does not fall within the scope of approved sentences. This will generally be for one of the following reasons:

a) data is intended for another device from the same manufacturer, is device specific, and not in a form or of a type of interest to the general user;
b) data is being used for test purposes prior to the adoption of approved sentences;
c) data is not of a type and general usefulness which merits the creation of an approved sentence.

The manufacturers' reference list of mnemonic codes is a component of the equivalent specification NMEA 0183. [2)]

A proprietary sentence contains, in the order shown, the following elements:

ASCII	HEX	Description
"$"	24	start of sentence
"P"	50	proprietary sentence ID
<aaa>		manufacturer's mnemonic code (The NMEA secretariat maintains the master reference list which comprises codes registered and formally adopted by NMEA)
[<valid characters,"^" and "," >]		Manufacturer's data
"*"<checksum field>		checksum field
<CR><LF>	0D 0A	end of sentence

Proprietary sentences shall include checksums and conform to requirements limiting overall sentence length. Manufacturer's data fields shall contain only valid characters but may include "^" and "," for delimiting or as manufacturer's data. Details of proprietary data fields are not included in this standard and need not be submitted for approval. However, it is required that such sentences be published in the manufacturer's manuals for reference.

5.3.4 Valid sentences

Approved sentences, query sentences and proprietary sentences are the only valid sentences. Sentences of any other form are non-valid and shall not be transmitted on the bus.

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2) The NMEA Secretariat maintains the master reference list which comprises codes registered and formally adopted by NMEA.

The address for the registration of manufacturer's codes is:

NMEA 0183 Standards Committee	Fax: +1-252-638-4885
P.O. Box 3435	e-mail: nmea@coastal.net
New Bern, NC 28564-3435	web site http://www.nmea.org
U.S.A.	

5.3.5 Sentence transmission timing

Frequency of sentence transmission when specified shall be in accordance with the approved sentence definitions (see 6.3). When not specified, the rate shall be consistent with the basic measurement or calculation cycle but generally not more frequently than once per second.

It is desirable that sentences be transmitted with minimum inter-character spacing, preferably as a near continuous burst, but under no circumstance shall the time to complete the transmission of a sentence be greater than 1 s.

5.3.6 Additions to approved sentences

In order to allow for improvements or additions, future revisions of this standard may modify existing sentences by adding new data fields after the last data field but before the checksum delimiter character "*" and checksum field. Listeners shall determine the end of the sentence by recognition of "<CR><LF>" and "*" rather than by counting field delimiters. The checksum value shall be computed on all received characters between, but not including, "$" and "*" whether or not the listener recognizes all fields.

6 Data content

6.1 Character definitions

Table 1 – Reserved characters

ASCII	HEX	DEC	Description
<CR>	0D	13	Carriage return
<LF>	0A	10	Line feed – End of sentence delimiter
$	24	36	Start of sentence delimiter
*	2A	42	Checksum field delimiter
,	2C	44	Field delimiter
!	21	33	Reserved for future use
\	5C	92	Reserved for future use
^	5E	94	Code delimiter for HEX representation of ISO 8859-1 (ASCII) characters
~	7E	126	Reserved for future use

Table 2 – Valid characters

ASCII	HEX	DEC	ASCII	HEX	DEC	ASCII	HEX	DEC
Space	20	32	@	40	64	`	60	96
Reserved	21	33	A	41	65	a	61	97
"	22	34	B	42	66	b	62	98
#	23	35	C	43	67	c	63	99
Reserved	24	36	D	44	68	d	64	100
%	25	37	E	45	69	e	65	101
&	26	38	F	46	70	f	66	102
'	27	39	G	47	71	g	67	103
(	28	40	H	48	72	h	68	104
)	29	41	I	49	73	i	69	105
Reserved	2A	42	J	4A	74	j	6A	106
+	2B	43	K	4B	75	k	6B	107
Reserved	2C	44	L	4C	76	l	6C	108
-	2D	45	M	4D	77	m	6D	109
.	2E	46	N	4E	78	n	6E	110
/	2F	47	O	4F	79	o	6F	111
0	30	48	P	50	80	p	70	112
1	31	49	Q	51	81	q	71	113
2	32	50	R	52	82	r	72	114
3	33	51	S	53	83	s	73	115
4	34	52	T	54	84	t	74	116
5	35	53	U	55	85	u	75	117
6	36	54	V	56	86	v	76	118
7	37	55	W	57	87	w	77	119
8	38	56	X	58	88	x	78	120
9	39	57	Y	59	89	y	79	121
:	3A	58	Z	5A	90	z	7A	122
;	3B	59	[	5B	91	{	7B	123
<	3C	60	Reserved	5C	92	|	7C	124
=	3D	61	]	5D	93	}	7D	125
>	3E	62	Reserved	5E	94	Reserved	7E	126
?	3F	63	_	5F	95	Reserved	7F	127

Table 3 – Character symbol

A	Status symbol; Yes; Data valid; Warning flag clear; Auto; Ampere
a	Alphabet character variable A through Z or a through z
B	Bar (pressure, 1 000 mb = 100 kPa(Pascal(Pa))),Bottom
C	Celsius (Degrees); Course-up
c	Valid character; Calculating
D	Degrees (of arc)
E	Error; East; Engine
F	Fathoms (1 fathom equals 1,828 766 m)
f	Feet (1 foot equals 0,304 79 m)
G	Great circle; Green
g	Good
H	Compass heading; Head-up; Hertz; Humidity
h	Hours; HEX number
I	Inches (1 inch equals 0,025 4 m)
J	Input operation completed
K	Kilometres; km/h
k	Kilograms
L	Left; Local; Lost target
l	Latitude; Litres; l/s
M	Metres; m/s; Magnetic; Manual; Cubic metres
m	Minutes; message
N	Nautical miles; Knots; North; North-up; Newtons
n	Numeral; address
P	Purple; Proprietary (only when following "$"); Position sensor; Per cent; Pascal (pressure)
Q	Query; Target-being-acquired
R	Right; Rhumb line; Red; Relative; Reference; Radar tracking; revolutions/min (RPM)
S	South; Statute miles (1 609,31 m); Statute miles/h; Shaft
s	Seconds
T	Time difference; True; Track; Tracked target
t	Test
U	Dead reckoning estimate
u	Sign, if minus "-" (HEX 2D)
V	Data invalid; No; Warning flag set; Manual; Volt
W	West; Water; Wheelover
x	Numeric character variable
y	Longitude
Z	Time

6.2 Field definitions

Table 4 – Talker identifier mnemonics

Talker device		*Identifier*
Heading/track controller (autopilot)	general	*AG
	magnetic	AP
Automatic identification system		A I
Communications:	digital selective calling (DSC)	*CD
	data receiver	CR
	satellite	*CS
	radio-telephone (MF/HF)	*CT
	radio-telephone (VHF)	*CV
	scanning receiver	*CX
DECCA navigator		DE
Direction finder		*DF
Electronic chart systems (ECS)		EC
Electronic chart display and information system (ECDIS)		EI
Emergency position indicating radio beacon (EPIRB)		*EP
Engine room monitoring systems		ER
Global positioning system (GPS)		GP
GLONASS receiver		GL
Global navigation satellite system (GNSS)		GN
Heading sensors:	compass, magnetic	*HC
	gyro, north seeking	*HE
	gyro, non-north seeking	HN
Integrated instrumentation		II
Integrated navigation		IN
LORAN: LORAN C		LC
Proprietary code		P
Radar and/or radar plotting		*RA
Sounder, depth		*SD
Electronic positioning system, other/general		SN
Sounder, scanning		SS
Turn rate indicator		*TI
Velocity sensors:	Doppler, other/general	*VD
	speed log, water, magnetic	VM
	speed log, water, mechanical	VW
Voyage data recorder		VR
Transducer		YX
Timekeepers, time/date:	atomic clock	ZA
	chronometer	ZC
	quartz	ZQ
	radio update	ZV
Weather instruments		WI

* Designated in this standard for use with IMO maritime electronic devices. This is the minimum requirement for equipment that is required by IMO in the SOLAS Convention (1974, as amended).

Table 5 – Approved sentence formatters

Formatter	*Meaning*
AAM	Waypoint arrival alarm
ACK	Acknowledgement alarm
ALM	GPS almanac data
ALR	Set alarm state
APB	Heading/track controller (Autopilot) sentence B
BEC	Bearing and distance to waypoint, dead reckoning
BOD	Bearing, origin to destination
BWC	Bearing and distance to waypoint
BWR	Bearing and distance to waypoint, rhumb line
BWW	Bearing, waypoint to waypoint
DBT	Depth below transducer
DCN	DECCA position
DPT	Depth
DSC	Digital selective calling information
DSE	Expanded digital selective calling
DSI	DSC transponder initialise
DSR	DSC transponder response
DTM	Datum reference
FSI	Frequency set information
GBS	GNSS Satellite fault detection
GGA	Global positioning system fix data
GLC	Geographic position, LORAN-C
GLL	Geographic position, latitude/longitude
GNS	GNSS fix data
GRS	GNSS range residuals
GSA	GNSS DOP and active satellites
GST	GNSS pseudorange error statistics
GSV	GNSS satellites in view
HDG	Heading, deviation and variation
HDT	Heading, true
HMR	Heading monitor – receive
HMS	Heading monitor – set
HSC	Heading steering command
HTC	Heading/track control command
HTD	Heading/track control data
LCD	LORAN-C signal data
MLA	Glonass almanac data
MSK	MSK receiver interface
MSS	MSK receiver signal status
MTW	Water temperature
MWD	Wind direction and speed
MWV	Wind speed and angle
OSD	Own ship data
RMA	Recommended minimum specific LORAN-C data
RMB	Recommended minimum navigation information
RMC	Recommended minimum specific GNSS data
ROT	Rate of turn
RPM	Revolutions
RSA	Rudder sensor angle
RSD	Radar system data
RTE	Routes
SFI	Scanning frequency information
STN	Multiple data ID
TLB	Target label
TLL	Target latitude and longitude
TTM	Tracked target message

TXT	Text transmission
VBW	Dual ground/water speed
VDR	Set and drift
VHW	Water speed and heading
VLW	Distance travelled through the water
VPW	Speed, measured parallel to wind
VTG	Course over ground and ground speed
WCV	Waypoint closure velocity
WNC	Distance, waypoint to waypoint
WPL	Waypoint location
XDR	Transducer measurements
XTE	Cross-track error, measured
XTR	Cross-track error, dead reckoning
ZDA	Time and date
ZDL	Time and distance to variable point
ZFO	UTC and time from origin waypoint
ZTG	UTC and time to destination waypoint

Table 6 – Field type summary

Field type	*Symbol*	*Definition*
Special format fields		
Status	A	Single character field: A = Yes, data valid, warning flag clear V = No, data invalid, warning flag set
Latitude	llll.ll	Fixed/variable length field: degrees/minutes and decimal – two fixed digits of degrees, two fixed digits of minutes and a variable number of digits for decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal fraction are optional if full resolution is not required.
Longitude	yyyyy.yy	Fixed/variable length field: degrees/minutes and decimal – three fixed digits of degrees, two fixed digits of minutes and a variable number of digits for decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal fraction are optional if full resolution is not required.
Time	hhmmss.ss	Fixed/variable length field: hours/minutes/seconds and decimal – two fixed digits of hours, two fixed digits of minutes, two fixed digits of seconds and a variable number of digits for decimal fraction of seconds. Leading zeros always included for hours, minutes and seconds to maintain fixed length. The decimal point and associated decimal fraction are optional if full resolution is not required.

Defined field		Some fields are specified to contain pre-defined constants, most often alpha characters. Such a field is indicated in this standard by the presence of one or more valid characters. Excluded from the list of allowable characters are the following which are used to indicate field types within this standard: "A", "a", "c", "hh", "hhmmss.ss", "llll.ll", "x", "yyyyy.yy".
Numeric value fields		
Variable numbers	x.x	Variable length integer or floating numeric field. Optional leading and trailing zeros. The decimal point and associated decimal fraction are optional if full resolution is not required (example: 73.10 = 73.1 = 073.1 = 73).
Fixed HEX field	hh-	Fixed length HEX numbers only, MSB on the left.
Information fields		
Variable text	c--c	Variable length valid character field.
Fixed alpha field	aa-	Fixed length field of upper-case or lower-case alpha characters.
Fixed number field	xx-	Fixed length field of numeric characters.
Fixed text field	cc-	Fixed length field of valid characters.

NOTE 1 Spaces shall only be used in variable text fields.

NOTE 2 A negative sign "–" (HEX 2D) is the first character in a field if the value is negative. When used, this increases the specified size of fixed length fields by one. The sign is omitted if the value is positive.

NOTE 3 Units of measure fields are appropriate characters from the symbol table (Table 3) unless a specific unit of measure is indicated.

6.3 Approved sentences

General format of printed sentence information:

[*] **{mnemonic} – {name}**

{definition paragraph}

$--{sentence}

{field descriptions}

start of sentence and talker ID

AAM – Waypoint arrival alarm

Status of arrival (entering the arrival circle, or passing the perpendicular of the course line) at waypoint c--c.

[*] Designated in this standard for use with IMO marine electronic devices as required by IMO in the SOLAS Convention (1974, as amended).

$--AAM, A, A,x.x, N, c--c*hh<CR><LF>

Waypoint ID
Units of radius, nautical miles
Arrival circle radius
Status: A = perpendicular passed at waypoint
Status: A = arrival circle entered

ACK – Acknowledge alarm

Acknowledge device alarm. This sentence is used to acknowledge an alarm condition reported by a device.

$--ACK,xxx*hh<CR><LF>

Local alarm number (identifier) [identification number of alarm source]

ALM – GPS almanac data

Contains GPS week number, satellite health and the complete almanac data for one satellite. Multiple messages may be transmitted, one for each satellite in the GPS constellation, up to a maximum of 32 messages.

$--ALM, x.x, x.x, xx, x.x, hh, hhhh, hh, hhhh, hhhh, hhhhhh, ..

$(A)^{½}$, root of semi-major axis (see note 3)
OMEGADOT, rate of right ascension (see note 3)
$(sigma)_i$, inclination angle (see note 3)
t_{oa}, almanac reference time (see note 3)
e, eccentricity (see note 3)
SV health, bits 17-24 of each almanac page (see note 2)
GPS week number (see note 1)
Satellite PRN number, 01 to 32
Message number
Total number of messages

..hhhhhh, hhhhhh, hhhhhh, hhh, hhh*hh<CR><LF>

Checksum
a_{f1},clock parameter (see note 3)
a_{fo}, clock parameter (see note 3)
M_0 mean anomaly (see note 3)
$OMEGA_0$, longitude of ascension node (see note 3)
(OMEGA), argument of perigee (see note 3)

(from ICD-GPS-200, revision B (see annex A))

NOTE 1 Variable length integer, four digits maximum (0 to 9999). This is an extended GPS week number to which the almanac reference time parameter (toa) is referenced. Week zero refers to the week of 06 January 1980. The value is the “Extended Week Number”, which is the elapsed number of weeks since week zero. Extended week numbers shall not be reset to zero when the 10-bit GPS week number rolls back to zero every 19,6 years. This value must be determined by the GPS receiver at the time of the almanac data decoding. It is based on the 8-bit Almanac Reference week form, Page 25, Subframe 5, word 3, bits 17 to 24; that 8-bit value must be expanded by the GPS receiver to give a full Extended Week Number. Furthermore, care must be taken to ensure that the Almanac Reference Time and the Extended Week Number are correctly linked as part of a single almanac data set, avoiding inconsistencies between different almanac data sets when new almanac uploads occur after reading Page 25 of Subframe 5.

NOTE 2 Reference 20.3.3.5.1.3, Table 20-VII and Table 20-VIII.

NOTE 3 Reference Table 20-VI, for scaling factors and units.

ALR – Set alarm state

Local alarm condition and status. This sentence is used to report an alarm condition on a device and its current state of acknowledgement.

$--ALR,hhmmss.ss,xxx,A, A,c--c*hh<CR><LF>

Alarm's description text
Alarm's acknowledge state, A = acknowledged
V = unacknowledged
Alarm condition (A = threshold exceeded, V = not exceeded)
Local alarm number (identifier) [identification number of alarm source]
Time of alarm condition change, UTC

APB – Heading/Track controller (autopilot) sentence B

Commonly used by autopilots, this sentence contains navigation receiver warning flag status, cross-track-error, waypoint arrival status, initial bearing from origin waypoint to the destination, continuous bearing from present position to destination and recommended heading to steer to destination waypoint for the active navigation leg of the journey.

$--APB, A, A, x.x, a, N, A, A, x.x, a, c--c, x.x, a, x.x, a, a*hh<CR><LF>

Mode indicator
(see notes 1 and 2)
Heading to steer to destination
waypoint, magnetic or true
Bearing, present position to
destination, magnetic or true
Destination waypoint ID
Bearing origin to destination, M/T
Status: A = perpendicular passed at waypoint
V = perpendicular not entered
Status: A = arrival circle entered V = arrival circle not passed
XTE units, nautical miles
Direction to steer, L/R
Magnitude of XTE (cross-track-error)
Status: A = OK or not used V = LORAN-C cycle lock warning flag (see note 2)
Status: A = Data valid V = LORAN-C blink or SNR warning (see note 2)
V = general warning flag for other navigation systems when a
reliable fix is not available

NOTE 1 Positioning system Mode indicator:

A = Autonomous mode

D = Differential mode

E = Estimated (dead reckoning) mode

M = Manual input mode

S = Simulator mode

N = Data not valid

NOTE 2 The positioning system Mode indicator field supplements the positioning system Status fields (fields 1 and 2), the Status fields shall be set to V = invalid for all values of Mode Indicator except for A = Autonomous and D = Differential. The positioning system Mode Indicator shall not be null fields.

BEC – Bearing and distance to waypoint – dead reckoning

Time (UTC) and distance and bearing to, and location of, a specified waypoint from the dead-reckoned present position.

```
$–BEC, hhmmss.ss, llll.ll, a, yyyyy.yy, a, x.x, T, x.x, M, x.x, N, c--c*hh<CR><LF>
```

```
Waypoint ID
Distance, nautical miles
Bearing, degrees magnetic
Bearing, degrees true
Waypoint longitude, E/W
Waypoint latitude, N/S
UTC of observation
```

BOD – Bearing origin to destination

Bearing angle of the line, calculated at the origin waypoint, extending to the destination waypoint from the origin waypoint for the active navigation leg of the journey.

```
$--BOD, x.x, T, x.x, M, c--c, c--c*hh<CR><LF>
```

```
Origin waypoint ID
Destination waypoint ID
Bearing, degrees magnetic
Bearing, degrees true
```

BWC – Bearing and distance to waypoint

BWR – Bearing and distance to waypoint – rhumb line

Time (UTC) and distance and bearing to, and location of, a specified waypoint from present position. $--BWR data is calculated along the rhumb line from present position rather than along the great circle path.

```
$--BWC, hhmmss.ss, llll.ll, a, yyyyy.yy, a, x.x, T, x.x, M, x.x, N, c--c, a*hh<CR><LF>
$--BWR, hhmmss.ss, llll.ll, a, yyyyy.yy, a, x.x, T, x.x, M, x.x, N, c--c, a*hh<CR><LF>
```

```
Mode indicator
(see note 1)
Waypoint ID
Distance, nautical miles
Bearing, degrees magnetic
Bearing, degrees true
Waypoint longitude, E/W
Waypoint latitude, N/S
UTC of observation
```

NOTE 1 Positioning system Mode indicator

A = Autonomous mode

D = Differential mode

E = Estimated (dead reckoning) mode

M = Manual input mode

S = Simulator mode

N = Data not valid

The Mode indicator field shall not be a null field.

BWW – Bearing waypoint to waypoint

Bearing angle of the line, between the TO and the FROM waypoints, calculated at the FROM waypoint for any two arbitrary waypoints.

$--BWW, x.x, T, x.x, M, c--c, c--c*hh<CR><LF>

FROM waypoint ID
TO waypoint ID
Bearing, degrees magnetic
Bearing, degrees true

DBT – Depth below transducer

Water depth referenced to the transducer.

$--DBT, x.x, f, x.x, M, x.x, F*hh<CR><LF>

Water depth, fathoms
Water depth, m
Water depth, feet

DCN – DECCA position

Status and lines-of-position for a specified DECCA chain.

$ -- DCN, xx, cc, x.x, A, cc, x.x, A, cc, x.x, A, A, A, A, x.x, N, x*hh<CR><LF>

Fix data basis (see note)
Position uncertainty, n. miles
Purple-line navigation use
A = Valid V = Data not valid
Green-line navigation use
A = Valid V = Data not valid
Red-line navigation use
A = Valid V = Data not valid
Purple
Green
Status: Red-master line, A = Valid V = Data not valid
Red line of position (LOP)
Red zone identifier, number-letter
DECCA chain identifier

NOTE Fix data basis:

1 = Normal pattern

2 = Lane identification pattern

3 = Lane identification transmissions

***DPT – Depth**

IMO Resolution A.224 (VII). Water depth relative to the transducer and offset of the measuring transducer. Positive offset numbers provide the distance from the transducer to the waterline. Negative offset numbers provide the distance from the transducer to the part of the keel of interest.

$--DPT, x.x, x.x, x.x*hh<CR><LF>

Maximum range scale in use
Offset from transducer, in metres (see notes 1 and 2)
Water depth relative to the transducer, in metres

NOTE 1 "positive" = distance from transducer to water line; "-" = distance from transducer to keel.

NOTE 2 For IEC applications the offset shall always be applied so as to provide depth relative to the keel.

***DSC – Digital selective calling information**

This sentence is used to receive a call from or provide data to a radiotelephone using digital selective calling in accordance with ITU-R M.493-9.

$ --DSC,xx,xxxxxxxxxx,xx,xx,xx,x.x, x.x,xxxxxxxxxx,xx, a,a*hh<CR><LF>

Expansion indicator (see note 1)
Acknowledgement (see note 2)
Nature of distress (see notes 3 and 4)
MMSI of ship in distress (see notes 3 and 5)
Time (see note 6) or Tel. No. (see note 7)
Position (see note 8) or Channel/Frequency (see note 9)
Type of Communication (see notes 4 and 11)
or Second Telecommand (see note 4)
Nature of Distress (see notes 4 and 10)
or First Telecommand (see note 4)
Category (see note 4)
Address (see note 5)
Format Specifier (see note 4)

NOTE 1 Expansion indicator = "E", null otherwise. When set to "E" this sentence is followed by the DSC Expansion sentence $--DSE, without intervening sentences, as the next transmitted or received sentence.

NOTE 2 Acknowledgement type:

R = Acknowledge request

B = Acknowledgement

S = Neither (end of sequence)

NOTE 3 For Distress Acknowledgement, Distress Relay and Distress Relay Acknowledgement calls only, null otherwise.

NOTE 4 Use two least-significant digits of symbol codes in ITU-R M.493-9, Table 3.

NOTE 5 Maritime Mobile Service Identifier (MMSI) for the station to be called or the MMSI of the calling station in a received call. For a nine-digit MMSI "0" shall be added as the tenth digit. For calls to a geographic area the area is coded in accordance with ITU-R M.493-9, paragraph 5.3 and Figure 6.

System configuration (wiring) and the Talker ID are used to confirm if the sentence is transmitted or received. The MMSI of the calling station for transmitted calls is inserted automatically in the ITU-R M.493-9 transmission at the radiotelephone.

NOTE 6 Time (UTC) of position, four digits, hhmm (hours and minutes).

NOTE 7 Telephone number, 16 digits maximum, odd/even information to be inserted by the DSC equipment.

NOTE 8 Latitude/longitude, degrees and minutes, 10 digits, coded in accordance with ITU-R M.493-9 paragraph 8.1.2

NOTE 9 Frequency or channel, six or twelve digits, coded in accordance with ITU-R M.493-9, Table 13.

NOTE 10 Distress calls only.

NOTE 11 Distress, Distress Acknowledgement, Distress Relay and Distress Relay Acknowledgement calls only.

DSE – Expanded Digital selective calling

This sentence immediately follows, without intervening sentences or characters, $--DSC, $--DSI or $--DSR when the DSC expansion field in these sentences is set to “E”. It is used to provide data to or receive DSC expansion data from a radiotelephone using Digital selective calling in accordance with ITU-R M.821-1.

$--DSE,x, x, a,xxxxxxxxxx, xx,c--c,..........,xx,c--c*hh<CR><LF>

Data set ‘n’ (see notes 1 and 2)
Additional data sets (see notes 1 and 2)
Data set ‘1’ (see notes 1 and 2)
Vessel MMSI (see note 3)
Query/reply flag (see note 4)
Message number (see note 5)
Total number of messages (see note 5)

NOTE 1 Data sets consist of two fields. The first field is the code field: the two least significant digits of symbol codes in ITU-R M.821-1, Table 1. The second field is the data field: the additional information required by ITU-R M.821-1, null otherwise. The digits appearing in these fields are the data or commands as specified by ITU-R M.821-1 except for commands, the two least significant digits of Table 3 of ITU-R M.821-1 are preceded by ASCII “C” (HEX 43). A variable number of data sets are allowed, null fields are not required for unused data sets.

NOTE 2 ASCII characters are used to describe text (station name and port of call), not symbols of ITU-R M.821-1, Table 2. When <,> (Comma, HEX 2C - a reserved character) is needed, <‘> (Apostrophe, HEX 27) is substituted.

NOTE 3 Identical to the address field in the associated $--DSC, $--DSI or $--DSR sentence.

NOTE 4 “Q” = Query. A device is requesting expanded data. Code fields filled as desired, all data fields null.

“R” = Reply. A device is responding with selected expanded data, in response to a query.

“A” = Automatic. A device is transmitting data automatically, not in response to a query request.

NOTE 5 The number of data sets may require the transmission of multiple messages all containing identical field formats. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1. For efficiency, it is recommended that null fields be used in the additional sentences when the data is unchanged from the first sentence.

DSI – DSC transponder initialise

This sentence is used to provide data to a radiotelephone for use in making calls using Digital selective calling in accordance with ITU-R M.825-3.

Expansion indicator (see note 1)
Command set ‘n’

$--DSI,x,x,xxxxxxxxxx,xxx,xx,xxxxxxxxxxxxxxxxxxxxxx,xx,c--c,.....,xx,c--c,a*hh<CR><LF>

Command sets (see notes 2 and 3)
Command set ‘1’
Geographical area, 0,01 min (see note 4)
Vessel type (see note 4)
Vessel course, degrees true (see note 4)
Vessel MMSI (see note 5)
Message number (see note 6)
Total number of messages (see note 6)

NOTE 1 Expansion indicator = “E”, null otherwise. When set to “E” this sentence is followed by the DSC Expansion sentence $--DSE, without intervening sentences or characters, as the next transmitted sentence.

NOTE 2 Command Sets consist of two fields. The first field is the two least significant digits of symbol codes in ITU-R M.825-3, Table 4, the second field is the additional information required by ITU-R M.825-3, null otherwise. A variable number of command sets are allowed, null fields are not required for unused command sets.

NOTE 3 ASCII characters are used to describe station name and port of call, not symbols of ITU-R M.825-3, Table 1. When <,> (Comma, HEX2C – a reserved character) is needed, <'> (Apostrophe, HEX 27) is substituted.

NOTE 4 All vessels in a geographic area or vessels of a specific type or on a specific course in that area, may be addressed. Code in accordance with ITU-R M.825-3, paragraph 5 and Table 3. These fields shall be null when the MMSI of an individual station is used.

NOTE 5 Maritime Mobile Service Identifiers (MMSI) for the individual station to be called. For a nine-digit MMSI "0" shall be added as the tenth digit. This field is null when addressing ships by area. Information relevant to the voyage of a ship may be provided by using the own ship MMSI together with the following command sets:

00, followed by the second digit of other ships in ITU-R M.825-3, Table 3 (status).
05, followed by a null second field (entering VTS).
07, followed by a null second field (leaving VTS).
14, followed by a second field beginning "00" or "01" as described in paragraph 8.1.5 of ITU-R M.825-3 (destination).
21, followed by a second field containing the next port of call.
23, followed by the draught as described in paragraph 8.1.10 of ITU-R M.825-3.

NOTE 6 The number of data sets may require the transmission of multiple messages all containing identical field formats. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1. For efficiency it is recommended that null fields be used in the additional sentences when the data is unchanged from the first sentence.

DSR – DSC transponder response

This sentence is used to receive data from a radiotelephone using Digital Selective Calling in accordance with ITU-R M.825-3.

```
$--DSR,x,x,xxxxxxxxxx,xx,c--c,......,xx,c--c,a*hh<CR><LF>
                                                  Expansion indicator (see note 1)
                                              Data Set 'n'
                                     Additional data sets (see notes 2 and 3)
                              Data set '1'
                   Vessel MMSI (see note 4)
           Message number (see note 5)
       Total number of messages (see note 5)
```

NOTE 1 Expansion indicator = "E", null otherwise. When set to "E" this sentence is followed by the DSC expansion sentence $--DSE, without intervening sentences or characters, as the next received sentence.

NOTE 2 Data Sets consist of two fields. The first field is the two least significant digits of symbol codes in ITU-R M.825-3, Table 4, the second field is the additional information required by ITU-R M.825-3, null otherwise. A variable number of data sets are allowed, null fields are not required for unused data sets.

NOTE 3 ASCII characters are used to describe station name and port of call, not symbols of ITU-R M.825-3, Table 1. When <,> (Comma, HEX 2C – a reserved character) is needed, <'> (Apostrophe, HEX 27) is substituted.

NOTE 4 Maritime Mobile Service Identifier (MMSI) of the station responding. For a nine digit MMSI "0" shall be added as the tenth digit.

NOTE 5 The number of data sets may require the transmission of multiple messages all containing identical field formats. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1. For efficiency, it is recommended that null fields be used in the additional sentences when the data is unchanged from the first sentence.

***DTM Datum reference**

Local geodetic datum and datum offsets from a reference datum. This sentence is used to define the datum to which a position location, and geographic locations in subsequent sentences, are referenced. Latitude, longitude and altitude offsets from the reference datum, and the selection of the reference datum, are also provided.

Cautionary notes: The datum sentence should be transmitted immediately prior to every positional sentence (e.g. GLL, BWC, WPL) which is referenced to a datum other than WGS84, the datum recommended by IMO.

For all datums the DTM sentence should be transmitted prior to any datum change and periodically at intervals of not greater than 30 s.

$--DTM,ccc,a,x.x,a,x.x,a, x.x,ccc*hh<CR><LF>

- Reference datum: WGS84 = W84, WGS72 = W72, SGS85 = S85, PE90 = P90
- Altitude offset, m (see note 3)
- Lon offset, min, E/W (see note 3)
- Lat offset, min, N/S (see note 3)
- Local datum subdivision code (see note 2)
- Local datum: (see note 1)
  - WGS84 = W84
  - WGS72 = W72
  - SGS85 = S85
  - PE90 = P90
  - User defined = 999
  - IHO datum code (see note 4)

NOTE 1 Three character alpha code for local datum. If not one of the listed earth-centred datums, or 999 for user defined datums, use IHO datum code from International Hydrographic Organisation Publication S-60, Appendices B and C. Null field if unknown.

NOTE 2 One character subdivision datum code when available or user defined reference character for user defined datums, null field otherwise. Subdivision character from IHO Publication S-60, Appendices B and C.

NOTE 3 Latitude and longitude offsets are positive numbers, the altitude offset may be negative. Offsets change with position: position in the local datum is offset from the position in the reference datum in the directions indicated:

$$\mathbf{P_{local\ datum} = P_{ref\ datum} + offset}$$

NOTE 4 Users should be aware that chart transformations based on IHO S60 parameters may result in significant positional errors when applied to chart data.

*FSI – Frequency set information

This sentence is used to set frequency, mode of operation and transmitter power level of a radiotelephone; to read out frequencies, mode and power and to acknowledge setting commands.

$--FSI, xxxxxx, xxxxxx,c,x*hh<CR><LF>

- Power level, 0 = standby, 1 = lowest, 9 = highest
- Mode of operation (see note 1)
- Receiving frequency (see notes 2 and 3)
- Transmitting frequency (see notes 2 and 3)

NOTE 1 Mode of operation:

d = F3E/G3E, simplex, telephone
e = F3E/G3E, duplex, telephone
m = J3E, telephone
o = H3E, telephone
q = F1B/J2B FEC NBDP, telex/teleprinter
s = F1B/J2B ARQ NBDP, telex/teleprinter
t = F1B/J2B, receive only, teleprinter/DSC
w = F1B/J2B, teleprinter/DSC
x = A1A Morse, tape recorder
{ = A1A Morse, morse key/head set
| = F1C/F2C/F3C, facsimile machine
null for no information.

NOTE 2 Frequencies to be in 100 Hz increments.

MF/HF telephone channels to have first digit 3, followed by ITU channel numbers with leading zeros as required. MF/HF teletype channels to have first digit 4; the second and third digit give the frequency bands, and the fourth to sixth digits ITU channel numbers; each with leading zeros as required. VHF channels to have the first digit 9 followed by zero. The next number is "1" indicating the ship station’s transmit frequency is being used as a simplex channel frequency, or "2" indicating the coast station’s transmit frequency is being used as a simplex channel frequency, "0" otherwise. The remaining three numbers are the VHF channel numbers with leading zeros as required.

NOTE 3 For paired frequencies, only the transmitting frequency needs to be included; null for receiving frequency field. For receive frequencies only, the transmitting frequency field shall be null.

GBS – GNSS satellite fault detection

This message is used to support receiver autonomous integrity monitoring (RAIM). Given that a GNSS receiver is tracking enough satellites to perform integrity checks of the positioning quality of the position solution, a message is needed to report the output of this process to other systems to advise the system user. With the RAIM in the GNSS receiver, the receiver can isolate faults to individual satellites and not use them in its position and velocity calculations. Also, the GNSS receiver can still track the satellite and easily judge when it is back within tolerance.

This message shall be used for reporting this RAIM information. To perform this integrity function, the GPS receiver must have at least two observables in addition to the minimum required for navigation. Normally these observables take the form of additional redundant satellites.

If only GPS, GLONASS, etc. is used for the reported position solution, the talker ID is GP,GL, etc. and the errors pertain to the individual system. If satellites from multiple systems are used to obtain the reported position solution, the talker ID is GN and the errors pertain to the combined solution.

$--GBS, hhmmss.ss, x.x, x.x, x.x, xx, x.x, x.x, x.x *hh <CR><LF>

Standard deviation of bias estimate
Estimate of bias on most likely failed satellite (see note 1)
Probability of missed detection for most likely failed satellite
ID number (see note 2) of most likely failed satellite
Expected error in altitude (see note 1)
Expected error in longitude (see note 1)
Expected error in latitude (see note 1)
UTC time of the GGA or GNS fix associated with this sentence

NOTE 1 Expected error in metres due to bias, with noise = 0.

NOTE 2 Satellite ID numbers. To avoid possible confusion caused by repetition of satellite ID numbers when using multiple satellite systems, the following convention has been adopted:

a) GPS satellites are identified by their PRN numbers, which range from 1 to 32.

b) The WAAS system has reserved numbers 33 – 64 to identify its satellites.

c) The numbers 65 – 96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64+ satellite slot numbers. The slot numbers are 1 through 24 for the full GLONASS constellation of 24 satellites, thus giving a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

GGA – Global positioning system (GPS) fix data

Time, position and fix-related data for a GPS receiver.

$--GGA, hhmmss.ss, llll.ll, a, yyyyy.yy, a, x, xx, x.x, x.x, M, x.x, M, x.x, xxxx*hh<CR><LF>

- hhmmss.ss – UTC of position
- llll.ll, a – Latitude N/S
- yyyyy.yy, a – Longitude E/W
- x – GPS quality indicator (see note 1)
- xx – Number of satellites in use, 00-12, may be different from the number in view
- x.x – Horizontal dilution of precision
- x.x – Antenna altitude above/below mean sea level (geoid)
- M – Units of antenna altitude, m
- x.x – Geoidal separation (see note 3)
- M – Units of geoidal separation,m
- x.x – Age of differential GPS data (see note 2)
- xxxx – Differential reference station ID, 0000-1023

NOTE 1 GPS quality indicator:

0 = fix not available or invalid
1 = GPS SPS mode, fix valid
2 = differential GPS, SPS mode, fix valid
3 = GPS PPS mode, fix valid
4 = Real Time Kinematic. Satellite system used in RTK mode with fixed integers
5 = Float RTK. Satellite system used in RTK mode with floating integers
6 = Estimated (dead reckoning) mode
7 = Manual input mode
8 = Simulator mode

The GPS Quality Indicator shall not be a null field.

NOTE 2 Time in seconds since last SC104 type 1 or 9 update, null field when DGPS is not used.

NOTE 3 Geoidal separation: the difference between the WGS-84 earth ellipsoid surface and mean sea level (geoid) surface, “ – “ = mean sea level surface below the WGS-84 ellipsoid surface.

GLC – Geographic position – LORAN-C

LORAN-C GRI, status and time difference (TD) lines of position for present vessel position.

$ -- GLC, xxxx, x.x, a, x.x, a, x.x, a, x.x, a, x.x, a, x.x, a*hh<CR><LF>

- xxxx – GRI, in tens of microseconds
- x.x, a – Master TOA microseconds (see note 1)
- x.x, a – TD1 (see note 2)
- x.x, a – TD2 (see note 2)
- x.x, a – TD3 (see note 2)
- x.x, a – TD4 (see note 2)
- x.x, a – TD5 (see note 2)
- a – Signal status in order of priority:
  - B = blink warning
  - C = cycle warning
  - S = SNR warning
  - A = Valid

NOTE 1 Master TOA provides for direct ranging operation. It may be the actual range to the Master in microseconds, or be offset and track the arrival of the Master signal.

NOTE 2 Time difference numbers in microseconds are in the LORAN-C coding delay order with null fields used when values are unavailable.

GLL – Geographic position – latitude/longitude

Latitude and longitude of vessel position, time of position fix and status.

$--GLL, llll.ll, a, yyyyy.yy, a, hhmmss.ss, A, a *hh<CR><LF>

Mode indicator (see notes 1 and 2)
Status (see note 2) A = data valid V = data invalid
UTC of position
Longitude, E/W
Latitude, N/S

NOTE 1 Positioning system Mode indicator:

A = Autonomous
D = Differential
E = Estimated (dead reckoning)
M = Manual input
S = Simulator
N = Data not valid

NOTE 2 The Mode Indicator field supplements the Status field (field 6). The Status field shall be set to V = invalid for all values of Operating Mode except for A = Autonomous and D = Differential. The positioning system Mode indicator and Status fields shall not be null fields.

GNS – GNSS fix data

Fix data for single or combined satellite navigation systems (GNSS). This sentence provides fix data for GPS, GLONASS, possible future satellite systems and systems combining these. This sentence could be used with the talker identification of GP for GPS, GL for GLONASS, GN for GNSS combined systems, as well as future identifiers. Some fields may be null fields for certain applications, as described below.

If a GNSS receiver is capable simultaneously of producing a position using combined satellite systems, as well as a position using only one of the satellite systems, then separate $GPGNS, $GLGNS, etc. messages may be used to report the data calculated from the individual systems.

If a GNSS receiver is set up to use more than one satellite system, but for some reason one or more of the systems are not available, then it may continue to report the positions using $GNGNS, and use the mode indicator to show which satellite systems are being used.

Differential reference station ID (see note 2)
Age of differential data (see note 2)
Geoidal separation, m (see note 4)
Antenna altitude, m,
re:mean-sea-level (geoid)

$-- GNS, hhmmss.ss, llll.ll, a, yyyyy.yy, a, c--c,xx,x.x,x.x,x.x,x.x,x.x,*hh<CR><LF>

HDOP (see note 3)
Total number of satellites in use, 00-99
Mode indicator (see note 1)
Longitude, E/W
Latitude, N/S
UTC of position

NOTE 1 Mode Indicator. A variable length valid character field type with the first two characters currently defined. The first character indicates the use of GPS satellites, the second character indicates the use of GLONASS satellites. If another satellite system is added to the standard, the mode indicator will be extended to three characters; new satellite systems shall always be added to the right, so the order of characters in the Mode Indicator is: GPS, GLONASS, other satellite systems.

The characters shall take one of the following values:

N = No fix. Satellite system not used in position fix, or fix not valid.
A = Autonomous.Satellite system used in non-differential mode in position fix.
D = Differential. Satellite system used in differential mode in position fix.
P = Precise. Satellite system used in precision mode. Precision mode is defined as: no deliberate degradation (such as Selective Availability), and higher resolution code (P-code) is used to compute position fix.
R = Real Time Kinematic. Satellite system used in RTK mode with fixed integers.
F = Float RTK. Satellite system used in real time kinematic mode with floating integers.
E = Estimated (dead reckoning) Mode.
M = Manual Input Mode.
S = Simulator Mode.

The Mode indicator shall not be a null field.

NOTE 2 Age of differential data and Differential reference station ID

a) When the talker is GN and more than one of the satellite systems are used in differential mode, then the "Age of differential data" and "Differential reference station ID" fields shall be null. In this case, the "Age of differential data" and "Differential reference station ID" fields shall be provided in following GNS messages with talker IDs of GP,GL, etc. These following GNS messages shall have the latitude, N/S, longitude, E/W, altitude, geoidal separation, mode and HDOP fields null. This indicates to the listener that the field is supporting a previous $GNGNS message with the same time tag. The "Number of satellites" field may be used in these following messages to denote the number of satellites used from that satellite system.

Example: A combined GPS/GLONASS receiver using only GPS differential corrections has the following GNS sentence sent:

$GNGNS,122310.2,3722.425671,N,12258.856215,W,DA,14,0.9,1005.543,6.5,5.2,23*59<CR><LF>

Example: A combined GPS/GLONASS receiver using both GPS differential corrections and GLONASS differential corrections may have the following three GNS sentences sent in a group:

$GNGNS,122310.2,3722.425671,N,12258.856215,W,DD,14,0.9,1005.543,6.5,,*74<CR><LF>

$GPGNS,122310.2, , , , , , 7, , , ,5.2,23*4D<CR><LF>

$GLGNS,122310.2, , , , , , 7, , , ,3.0,23*55<CR><LF>

The Differential Reference station ID may be the same or different for the different satellite systems

b) Age of Differential Data

For GPS differential data: This value is the average of the most recent differential corrections in use. When only RTCM SC104 Type 1 corrections are used, the age is that of the most recent Type 1 correction. When RTCM SC104 Type 9 corrections are used solely, or in combination with Type 1 corrections, the age is the average of the most recent corrections for the satellites used. Null field when Differential GPS is not used.

For GLONASS differential data: This value is the average age of the most recent differential corrections in use. When only RTCM SC104 Type 31 corrections are used, the age is that of the most recent Type 31 correction. When RTCM SC104 Type 34 corrections are used solely, or in combination with Type 31 corrections, the age is the average of the most recent corrections for the satellites used. Null field when differential GLONASS is not used.

NOTE 3 HDOP calculated using all the satellites (GPS, GLONASS and any future satellites) used in computing the solution reported in each GNS sentence.

NOTE 4 Geoidal separation is the difference between the earth ellipsoid surface and mean-sea-level (geoid) surface defined by the reference datum used in the position solution, "-" = mean-sea-level surface below ellipsoid surface. The reference datum may be specified in the DTM sentence.

GRS – GNSS range residuals

This message is used to support receiver autonomous integrity monitoring (RAIM). Range residuals can be computed in two ways for this process. The basic measurement integration cycle of most navigation filters generates a set of residuals and uses these to update the position state of the receiver. These residuals can be reported with GRS, but because of the fact that these were used to generate the navigation solution, they should be re-computed using the new solution in order to reflect the residuals for the position solution in the GGA or GNS message. The MODE field should indicate which computation method was used.

An integrity process that uses these range residuals would also require GGA or GNS, GSA and GSV messages to be sent.

If only GPS, GLONASS, etc. is used for the reported position solution, the talker ID is GP,GL, etc. and the range residuals pertain to the individual system. If GPS, GLONASS, etc. are combined to obtain the position solution, multiple GRS messages are produced, one with the GPS satellites, another with the GLONASS satellites, etc. Each of these GRS messages shall have talker ID “GN”, to indicate that the satellites are used in a combined solution. It is important to distinguish the residuals from those that would be produced by a GPS-only, GLONASS-only, etc. position solution. In general the residuals for a combined solution will be different from the residual for a GPS-only, GLONASS-only, etc. solution.

$--GRS, hhmmss.ss,x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x *hh<CR><LF>

Range residuals for satellites used in the navigation solution (see notes 1 and 2)
Order must match order of satellite ID (see note 3) numbers in GSA.
When GRS is used, GSA and GSV are generally required. Null for unused fields

Mode: 0 = residuals were used to calculate the position given in the matching GGA or GNS sentence
1 = residuals were re-computed after the GGA or GNS position was computed

UTC time of the GGA or GNS fix associated with this sentence

NOTE 1 If the range residual exceeds ±99,9 m, then the decimal part is dropped, resulting in an integer (–103,7 becomes –103). The maximum value for this field is ±999.

NOTE 2 The sense or sign of the range residual is determined by the order of parameters used in the calculation. The expected order is as follows: range residual = calculated range – measured range.

NOTE 3 When multiple GRS messages are being sent, their order of transmission must match the order of corresponding GSA messages. Listeners shall keep track of pairs of GSA and GRS sentences and discard data if pairs are incomplete.

GSA – GNSS DOP and active satellites

GNSS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentences, and DOP values. If only GPS, GLONASS, etc. is used for the reported position solution, the talker ID is GP, GL, etc. and the DOP values pertain to the individual system. If GPS, GLONASS, etc. are combined to obtain the reported position solution, multiple GSA messages are produced, one with the GPS satellites, another with the GLONASS satellites, etc. Each of these GSA messages shall have talker ID GN, to indicate that the satellites are used in a combined solution and each shall have the PDOP, HDOP and VDOP for the combined satellites used in the position.

$--GSA, a, x, xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x*hh<CR><LF>

VDOP
HDOP
PDOP
ID numbers (see note 1) of satellites used in solution
Mode: 1 = fix not available, 2 = 2 D, 3 = 3 D
Mode: M = manual, forced to operate in 2D or 3D mode
A = automatic, allowed to automatically switch 2D/3D

NOTE Satellite ID numbers. To avoid possible confusion caused by repitition of satellite ID numbers when using multiple satellite systems, the following convention has been adopted:

a) GPS satellites are identified by their PRN numbers, which range from 1 to 32.

b) The WAAS system has rserved numbers 33 – 64 to identify its satellites.

c) The numbers 65 – 96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64+ satellite slot numbers. The slot numbers are 1 through 24 for the full GLONASS constellation of 24 satellites, thus giving a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

GST – GNSS pseudorange noise statistics

This message is used to support receiver autonomous integrity monitoring (RAIM). Pseudorange measurement noise statistics can be translated in the position domain in order to give statistical measures of the quality of the position solution. If only GPS, GLONASS, etc. is used for the reported position solution, the talker ID is GP,GL, etc. and the error data pertain to the individual system. If satellites from multiple systems are used to obtain the position solution, the talker ID is GN and the errors pertain to the combined solution.

$--GST, hhmmss.ss, x.x, x.x, x.x, x.x, x.x, x.x, x.x*hh<CR><LF>

Standard deviation of altitude error, (m)
Standard deviation of longitude error, (m)
Standard deviation of latitude error, (m)
Orientation of semi-major axis of error ellipse (degrees from true north)
Standard deviation of semi-minor axis of error ellipse (m)
Standard deviation of semi-major axis of error ellipse, (m)
RMS value of the standard deviation of the range inputs to the navigation process. Range inputs include pseudoranges and DGPS corrections
UTC time of the GGA or GNS fix associated with this sentence

GSV – GNSS satellites in view

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth and SNR value. Four satellites maximum per transmission, additional satellite data sent in second or third message. Total number of messages being transmitted and the number of the message being transmitted is indicated in the first two fields.

If multiple GPS, GLONASS, etc. satellites are in view, use separate GSV sentences with talker ID GP to show the GPS satellites in view, and talker GL to show the GLONASS satellites in view, etc. The GN identifier shall not be used with this sentence.

$--GSV, x, x, xx, xx, xx, xxx, xx ...., xx, xx, xxx, xx*hh<CR><LF>

Fourth SV (see note 2)
Second and third SVs (see note 2)
SNR (C/No) 00-99 dB-Hz, null when not tracking
Azimuth, degrees true, 000 to 359
Elevation, degrees, 90° maximum
Satellite ID number (see note 3)
Total number of satellites in view
Message number (see note 1), 1 to 9
Total number of messages (see note 1), 1 to 9

NOTE 1 Satellite information may require the transmission of multiple messages, all containing identical field formats. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1. For efficiency it is recommended that null fields be used in the additional sentences where the data is unchanged from the first sentence.

NOTE 2 A variable number of "Satellite ID-Elevation-Azimuth-SNR" sets are allowed up to a maximum of four sets per message. Null fields are not required for unused sets when less than four sets are transmitted.

NOTE 3 Satellite ID numbers. To avoid posssible confusion caused by repitition of satellite ID numbers when using multiple satellite systems, the following convention has been adopted:

a) GPS satellites are identified by their PRN numbers, which range from 1 to 32.
b) The WAAS system has reserved numbers 33 – 64 to identify its satellites.
c) The numbers 65 – 96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64 + satellite slot numbers. The slot numbers are 1 through 24 for the full GLONASS constellation of 24 satellites, thus giving a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

*HDG – Heading, deviation and variation

IMO Resolution A.382 (X). Heading (magnetic sensor reading), which if corrected for deviation will produce magnetic heading, which if offset by variation will provide true heading.

$--HDG, x.x, x.x, a, x.x, a*hh<CR><LF>

Magnetic variation,degrees E/W (see notes 2 and 3)
Magnetic deviation, degrees E/W (see notes 1 and 3)
Magnetic sensor heading, degrees

NOTE 1 To obtain magnetic heading: add easterly deviation (E) to magnetic sensor reading;
subtract westerly deviation (W) from magnetic sensor reading.

NOTE 2 To obtain true heading: add easterly variation (E) to magnetic heading;
subtract westerly variation (W) from magnetic heading.

NOTE 3 Variation and deviation fields will be null fields if unknown.

***HDT – Heading true**

IMO Resolutions A.424 and A.821. Actual vessel heading in degrees true produced by any device or system producing true heading.

$--HDT, x.x, T*hh<CR><LF>

Heading, degrees true

***HMR – Heading monitor receive**

IMO MSC 64(67) Annex 3. Heading monitor receive: this sentence delivers data from the sensors selected by HMS from a central data collecting unit and delivers them to the heading monitor.

$--HMR,c--c,c--c,x.x,x.x,A,x.x,A,a,x.x,a,x.x,A, a, x.x,a,x.x,a*hh<CR><LF>

Variation,degrees E/W
(see notes 1 and 3)
Deviation Sensor 2 , degrees E/W
(see notes 1 and 2)
Sensor 2 Type T = True
M = Magnetic (see note 1)
Status heading sensor 2: A = Data Valid
V = Data Invalid
Actual Heading reading Sensor 2, degrees
Deviation Sensor 1, degrees E/W (see notes 1 and 2)
Sensor 1 Type T = True
M = Magnetic
Status heading sensor 1: A = Data Valid
V = Data Invalid
Actual Heading reading Sensor 1, degrees
Warning Flag: A = difference within set Limit
V = difference exceeds set Limit
Actual heading sensor difference, degrees
Set difference by HMS, degrees
Heading Sensor 2, ID
Heading Sensor 1, ID

NOTE 1 For magnetic sensors used, the deviation for the sensors and the variation of the area should be obtained; otherwise, or if unknown, null fields.

NOTE 2 To obtain Magnetic heading: add Easterly deviation (E) to magnetic sensor reading;
subtract Westerly deviation (W) from magnetic sensor reading.

NOTE 3 To obtain True heading: add Easterly variation (E) to magnetic heading;
subtract Westerly variation (W) from magnetic heading.

***HMS – Heading monitor set**

IMO – MSC 64(67), Annex 3. Set heading monitor: two heading sources may be selected and the permitted maximum difference may then be set.

$--HMS,c--c,c--c,x.x*hh<CR> <LF>

Maximum difference, degrees (see note)
Heading sensor 2, ID
Heading sensor 1, ID

NOTE Maximum difference between both sensors which is accepted.

HSC – Heading steering command

Commanded heading to steer vessel.

$--HSC, x.x, T, x.x, M*hh<CR><LF>

Commanded heading, degrees magnetic
Commanded heading, degrees true

***HTC – Heading/Track control command**
***HTD – Heading /Track control data**

IMO – MSC 64(67) Annex 3. Commands to, and data from, heading control systems. Provides input to (HTC) a heading controller to set values, modes and references; or provides output from (HTD) a heading controller with information about values, modes and references in use.

$--HTC,A,x.x,a,a,a,x.x,x.x,x.x,x.x,x.x,x.x, x.x,a*hh<CR><LF>
$--HTD,A,x.x,a,a,a,x.x,x.x,x.x,x.x,x.x,x.x,x.x,a,A, A, A,x.x,*hh<CR><LF>

Vessel heading, degrees
Off-track status (see note 5)
Off-heading status
Rudder status
A =within limits
V=limit reached or exceeded
Heading reference in use, T/M
Commanded track (see notes 4 and 6), degrees
Commanded off-track limit (see note 5), n.miles (unsigned)
Commanded heading-to-steer (see note 6), degrees
Commanded rate of turn for heading changes, °/min
Commanded radius of turn for heading changes, n.miles
Commanded off-heading limit, degrees (unsigned)
Commanded rudder limit, degrees (unsigned)
Turn mode (see note 3) R = radius controlled,
T = turn rate controlled
N = turn is not controlled
Selected steering mode (see note 2)
Commanded rudder direction, L/R = port/starboard
Commanded rudder angle, degrees
Override (see note 1), A = in use, V = not in use

NOTE 1 Override provides direct control of the steering gear. In the context of this sentence override means a temporary interruption of the selected steering mode. In this period steering is performed by special devices. As long as field "Override" is set to "A", both fields "Selected steering mode" and " Turn mode" shall be ignored by the heading/track controller and its computing parts shall operate as if manual steering was selected.

NOTE 2 All steering modes represent steering as selected by a steering selector switch or by a preceding HTC sentence. Priority levels of these inputs and usage/acceptance of related fields are to be defined and documented by the manufacturer.

Selected steering modes may be:

M = Manual steering. The main steering system is in use.

S = Stand-alone (heading control). The system works as a stand-alone heading controller. Field ”Commanded heading to steer” is not accepted as an input.

H = Heading control. Input of commanded heading to steer is from an external device and the system works as a remotely controlled heading controller. Field "Commanded heading to steer" is accepted as an input.

T = Track control. The system works as a track controller by correcting a course received in field “Commanded track”. Corrections are made based on additionally received track errors (e.g. from sentence XTE, APB, …).

R = Rudder control. Input of commanded rudder angle and direction from an external device. The system accepts values given in fields “Commanded rudder angle” and “Commanded rudder direction” and controls the steering by the same electronic means as used in modes S, H or T.

NOTE 3 Turn mode defines how the ship changes heading when in steering modes S, H or T according to the selected turn mode values given in fields “Commanded radius of turn” or “Commanded rate of turn”. With turn mode set to “N”, turns are not controlled but depend upon the ship’s manoeuverability and applied rudder angles only.

NOTE 4 Commanded track represents the course line (leg) between two waypoints. It may be altered dynamically in a track-controlled turn along a pre-planned radius.

NOTE 5 Off-track staus can be generated if the selected steering mode is “T”.

NOTE 6 Data in these fields shall be related to the heading reference in use.

LCD – LORAN-C signal data

Signal-to-noise ratio and pulse shape (ECD) data for LORAN-C signals.

Secondary S5 (see note) relative ECD, 000 to 999
Secondary S5 (see note) relative SNR, 000 to 999
(unsigned numbers)

$--LCD, xxxx,xxx xxx,xxx,xxx,xxx,xxx,xxx,xxx,xxx,xxx,xxx,xxx*hh<CR><LF>

S4 (see note)
S3 (see note)
S2 (see note)
S1 (see note)
Master
GRI, tens of microseconds

NOTE Data is in the LORAN-C coding delay order, with null fields used when values are unavailable.

MLA – GLONASS almanac data

Contains complete almanac data for one GLONASS satellite. All data are transmitted in accordance with the GLONASS Interface control document. Multiple messages may be transmitted, one for each satellite in the GLONASS configuration.

τ_n^A, course value of the time scale shift (see note 1)
τ_c^A, 12 LSB of system time scale correction (see note 1)
Δi_n^A, correction to the average value of the inclination angle (see note 1)
λ_n^A, Greenwich longitude of the ascension node (see note 1)
t_n^A, time of the ascension node almanac reference time (see note 1)
ΔT_n^A, correction to the average value of the draconitic circling time (see note 1)

$--MLA,x.x,x.x,xx,x.x,hh,hhhh,hh,hhhh,hhhh,hhhhhh,hhhhhh,hhhhhh,hhhhhh,hhh,hhh*hh<CR><LR>

τ_c^A, 16 MSB of system time scale correction (see note 1)
ω_n^A, argument of perigee (see note 1)
(ΔT_n^A)DOT, rate of change of the draconic circling time (see note 1)
ε_n^A, eccentricity (see note 1)
C_n^A and H_n^A, generalised health of the satellite and carrier frequency number respectively (see note 2)
N^A, calendar day count within the four year period beginning with the previous leap year
n^A, satellite ID (satellite slot) number (see note 3)
Message number
Total number of messages

(Reference GLONASS Interface control document, 1995)

NOTE 1 Section 4.5, Table 4.3. The least significant bits (LSB, low bits) of the HEX data field correspond to the LSB of the word indicated in Table 4.3. If the number of available bits in the HEX field is greater than is necessary to represent the word in Table 4.3, then the most significant bits (MSB, upper bits) of the Hex field are unused and filled with zero (0).

NOTE 2 C_n^A and H_n^A from the GLONASS Interface control document are represented in this 2-character HEX field as follows:

hh = [8][7][6][5][4][3][2][1] (LSB)

- [5]–[1]: H_n^A, carrier frequency number of satellite
- [7][6]: spare bits
- [8]: C_n^A, generalised health of satellite

NOTE 3 The numbers 65 – 96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64+ satellite slot numbers. The slot numbers are 1 through 24 for the full GLONASS constellation of 24 satellites; this gives a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

MSK – MSK receiver interface

Command message to a radiobeacon MSK receiver (beacon receiver) or reply from an MSK receiver to a query sentence

$--MSK, x.x,a,x.x,a,x.x,x*hh<CR><LF>

- Channel number (see note 3)
- Interval for sending $--MSS (status) (s) (see note 1)
- Auto/manual bit rate A/M (see note 2)
- Beacon bit rate (25, 50, 100, 200), bits/s
- Auto/manual frequency, A/M (see note 2)
- Beacon frequency (283,5 – 325,0 kHz)

NOTE 1 When status data is not to be transmitted this field shall be null.

NOTE 2 If Auto is specified, the previous field is ignored.

NOTE 3 Set equal to "1" or null for single channel receivers.

MSS – MSK receiver signal status

Signal-to-noise ratio, signal strength, frequency and bit rate from a MSK beacon receiver.

$--MSS,x.x,x.x,x.x,x.x,x*hh<CR><LF>

- Channel number (see note)
- Beacon bit rate (25,50, 100, 200) bits/s
- Beacon frequency, 283,5 – 325,0 kHz
- Signal-to-noise ratio (SNR), dB
- Signal strength (SS), dB/1 µV/m

NOTE Set equal to "1" or null for single channel receivers

In addition the beacon receiver shall respond to queries using the standard query request (Q). See 7.1.6 for examples.

MTW – Water temperature

$-- MTW, x.x, C*hh<CR><LF>

- Temperature, degrees C

MWD – Wind direction and speed

The direction from which the wind blows across the earth's surface, with respect to north, and the speed of the wind.

$--MWD, x.x,T,x.x,M,x.x,N,x.x,M*hh<CR><LF>

Wind speed, m/s
Wind speed, knots
Wind direction, 0° to 359° Magnetic
Wind direction, 0° to 359° True

***MWV – Wind speed and angle**

When the reference field is set to R (Relative), data is provided giving the wind angle in relation to the vessel's bow/centreline and the wind speed, both relative to the (moving) vessel. Also called apparent wind, this is the wind speed as felt when standing on the (moving) ship.

When the reference field is set to T (Theoretical, calculated actual wind), data is provided giving the wind angle in relation to the vessel's bow/centreline and the wind speed as if the vessel was stationary. On a moving ship these data can be calculated by combining the measured relative wind with the vessel's own speed.

Example 1: If the vessel is heading west at 7 knots and the wind is from the east at 10 knots the relative wind is 3 knots at 180 degrees. In this same example the theoretical wind is 10 knots at 180 degrees (if the boat suddenly stops, the wind will be at the full 10 knots and come from the stern of the vessel 180 degrees from the bow).

Example 2: If the vessel is heading west at 5 knots and the wind is from the southeast at 7,07 knots, the relative wind is 5 knots at 270 degrees. In this same example the theoretical wind is 7,07 knots at 225 degrees (if the boat suddenly stops, the wind will be at the full 7,07 knots and come from the port-quarter of the vessel 225 degrees from the bow).

$--MWV, x.x, a, x.x, a, A *hh<CR><LF>

Status, A = data valid V= data invalid
Wind speed units, K = km/h
M = m/s
N = knots
Wind speed
Reference, R = relative, T = true
Wind angle, 0° to 359°

***OSD Own ship data**

IMO Resolution A.477 and MSC 64(67), Annex 1 and Annex 3. Heading, course, speed, set and drift summary. Useful for, but not limited to radar/ARPA applications. OSD gives the movement vector of the ship based on the sensors and parameters in use.

```
$--OSD, x.x,A,x.x, a,x.x,a,x.x,x.x,a*hh<CR><LF>
```

- Speed units, K = km/h; N = Knots; S = statute miles/h
- Vessel drift (speed) — Manually entered
- Vessel set, degrees true — Manually entered
- Speed reference,B/M/W/R/P (see note)
- Vessel speed
- Course reference, B/M/W/R/P (see note)
- Vessel course, degrees true
- Heading status: A = data valid, V = data invalid
- Heading, degrees true

NOTE Reference systems on which the calculation of vessel course and speed is based. The values of course and speed are derived directly from the referenced system and do not additionally include the effects of data in the set and drift fields.

B = bottom tracking log

M = manually entered

W = water referenced

R = radar tracking (of fixed target)

P = positioning system ground reference.

RMA – Recommended minimum specific LORAN-C data

Position, course and speed data provided by a LORAN-C receiver. Time differences A and B are those used in computing latitude/longitude. This sentence is transmitted at intervals not exceeding 2 s and is always accompanied by RMB when a destination waypoint is active. RMA and RMB are the recommended minimum data to be provided by a LORAN-C receiver. All data fields must be provided, null fields used only when data is temporarily unavailable.

```
$--RMA, A, llll.ll, a, yyyyy.yy, a, x.x, x.x, x.x, x.x, x.x,a,a*hh<CR><LF>
```

- Mode indicator (see notes 2 and 3)
- Magnetic variation, degrees E/W (see note 1)
- Course over ground, degrees true
- Speed over ground, knots
- Time difference B, µs
- Time difference A, µs
- Longitude, degrees E/W
- Latitude, degrees N/S
- Status (see note 3): A = data valid, V = blink, cycle or SNR warning

NOTE 1 Easterly variation (E) subtracts from true course. Westerly variation (W) adds to true course.

NOTE 2 Positioning system Mode Indicator:

A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual input mode
S = Simulator mode
N = Data not valid

NOTE 3 The positioning system Mode indicator field supplements the Status field (field No. 1), which shall be set to V = invalid for all values of Mode indicator except for A = Autonomous and D = Differential. The positioning system Mode indicator and Status fields shall not be null fields.

RMB – Recommended minimum navigation information

Navigation data from present position to a destination waypoint provided by a LORAN-C, GNSS, DECCA, navigation computer or other integrated navigation system. This sentence always accompanies RMA or RMC sentences when a destination is active when provided by a LORAN-C, or GNSS receiver, other systems may transmit $--RMB without $--RMA or $--RMC.

$--RMB, A, x.x, a, c--c, c--c, llll.ll, a, yyyyy.yy,a,x.x, x.x, x.x, A, a *hh<CR><LF>

Mode indicator (see notes 3 and 4)
Arrival status
A = arrival circle, entered or perpendicular passed
V = not entered or passed
Destination closing velocity, knots
Bearing to destination, degrees true
Range to destination, nautical miles (see note 1)
Destination waypoint longitude, E/W
Destination waypoint latitude, N/S
Destination waypoint ID
Origin waypoint ID
Direction to steer L/R
Cross track error (see note 2), nautical miles
Status (see note 4): A = data valid
V = navigation receiver warning

NOTE 1 If range to destination exceeds 999,9 nautical miles, display 999,9.

NOTE 2 If cross track error exceeds 9,99 nautical miles, display 9,99.

NOTE 3 Positioning system Mode indicator:

A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual input mode
S = Simulator mode
N = Data not valid

NOTE 4 The positioning system Mode indicator field supplements the Status field (field No. 1) which shall be set to V = invalid for all values of Mode indicator except for A = Autonomous and D = Differential. The positioning system Mode indicator and Status fields shall not be null field.

RMC Recommended minimum specific GNSS data

Time, date, position, course and speed data provided by a GNSS navigation receiver. This sentence is transmitted at intervals not exceeding 2 s and is always accompanied by RMB when a destination waypoint is active. RMC and RMB are the recommended minimum data to be provided by a GNSS receiver. All data fields must be provided, null fields used only when data is temporarily unavailable.

$--RMC, hhmmss.ss, A, llll.ll,a, yyyyy.yy, a, x.x, x.x, xxxxxx, x.x,a, a*hh<CR><LF>

Mode indicator (see notes 2 and 3)
Magnetic variation, degrees, E/W
Date: dd/mm/yy
Course over ground, degrees true
Speed over ground, knots
Longitude, E/W (see note 1)
Latitude, N/S
Status (see note 3) A = data valid V = navigation receiver warning
UTC of position fix

NOTE 1 Easterly variation (E) subtracts from true course. Westerly variation (W) adds to true course.

NOTE 2 Positioning system Mode indicator:

A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual mode
S = Simulator mode
N = Data not valid

NOTE 3 The positioning system Mode indicator field supplements the positioning system Status field (field No. 2) which shall be set to V = invalid for all values of Mode indicator except for A = Autonomous and D = Differential. The positioning system Mode indicator and Status fields shall not be null fields.

***ROT – Rate of turn**

IMO Resolution A.526. Rate of turn and direction of turn.

$--ROT, x.x, A*hh<CR><LF>

Status: A = data valid
V = data invalid
Rate of turn, °/min, "-" = bow turns to port

***RPM Revolutions**

IMO Resolution (none). Shaft or engine revolution rate and propeller pitch

```
$--RPM,  a, x, x.x, x.x, A*hh<CR><LF>
```

Status: A = data valid V = data invalid
Propeller pitch, % of maximum, "-" = astern
Speed, revolutions/min, "-" = counter-clockwise
Engine or shaft number, numbered from centre-line
odd = starboard, even = port,
0 = single or on centre-line
Source, shaft/engine S/E

***RSA Rudder sensor angle**

IMO Resolution (none). Relative rudder angle,from rudder angle sensor.

```
$--RSA, x.x, A, x.x, A*hh<CR><LF>
```

Port rudder sensor (see notes 1 and 2)
Status A = data valid,
V = data invalid
Starboard (or single) rudder sensor (see notes 1 and 2)
Status A = valid,
V = data invalid

NOTE 1 Relative measurement of rudder angle without units, "-" = bow turns to port. Sensor output is proportional to rudder angle but not necessarily 1:1.

NOTE 2 The status field shall not be a null field.

***RSD Radar system data**

IMO Resolution A.820:1995 and MSC 64(67), Annex 4: Radar display setting data.

```
$--RSD, x.x, x.x,x.x, x.x,x.x, x.x,x.x, x.x,x.x, x.x, x.x, a, a*hh<CR><LF>
```

Display rotation (see note 1)
Range units, K = km
N = nautical miles
S = statute miles
Range scale in use
Cursor bearing, degrees clockwise from 0°
Cursor range, from own ship
EBL 2, degrees
VRM 2, range
Origin 2 bearing (see note 2)
Origin 2 range (see note 2)
Bearing line 1 (EBL1), degrees from 0°
Variable range marker 1 (VRM1), range
Origin 1 bearing (see note 2) degrees from 0°
Origin 1 range (see note 2), from own ship

NOTE 1 Display rotation:

C = course-up, course-over-ground up, degrees true
H = head-up, ship's heading (centre-line) 0° up
N = north-up, true north is 0° up

NOTE 2 Origin 1 and origin 2 are located at the stated range and bearing from own ship and provide for two independent sets of variable range markers (VRM) and electronic bearing lines (EBL) originating away from own ship position.

RTE – Routes

Waypoint identifiers, listed in order with starting waypoint first, for the identified route. Two modes of transmission are provided: "c" indicates that the complete list of waypoints in the route is being transmitted; "w" indicates a working route where the first listed waypoint is always the last waypoint that had been reached (FROM), while the second listed waypoint is always the waypoint that the vessel is currently heading for (TO) and the remaining list of waypoints represents the remainder of the route.

$--RTE, x.x, x.x, a, c--c, c--c, ... c--c*hh<CR><LF>

Waypoint "n" identifier (see note 1)
Additional waypoint identifiers (see note 1)
Waypoint identifier
Route identifier
Message mode: c = complete route, all waypoints
w = working route, first listed waypoint is "FROM",
second is "TO" and remaining are rest of route
Message number (see note 2)
Total number of messages being transmitted (see note 2)

NOTE 1 A variable number of waypoint identifiers, up to "n", may be included within the limits of allowed sentence length. As there is no specified number of waypoints, null fields are not required for waypoint identifier fields.

NOTE 2 A single route may require the transmission of multiple messages all containing identical field formats. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1. For efficiency, it is recommended that null fields be used in the additional sentences when the data is unchanged from the first sentence.

***SFI – Scanning frequency information**

This sentence is used to set frequencies and mode of operation for scanning purposes and to acknowledge setting commands. Scanning frequencies are listed in order of scanning. For DSC distress and safety watchkeeping only six channels shall be scanned in the same scanning sequence. To indicate a frequency set at the scanning receiver, use FSI sentence.

$--SFI, x.x, x.x, xxxxxx, c, ...,xxxxxx, c*hh<CR><LF>

Sixth frequency, mode (see note 3)
Second to fifth frequency, mode (see note 3)
Mode of operation (see note 1)
First frequency or ITU channel (see note 2)
Message number (see note 4)
Total number of messages being transmitted (see note 4)

NOTE 1 Mode of operation:

d = F3E/G3E simplex, telephone
e = F3E/G3E duplex, telephone
m = J3E, telephone
o = H3E, telephone
q = F1B/J2B FEC NBDP, Telex/teleprinter
s = F1B/J2B ARQ NBDP, Telex/teleprinter
t = F1B/J2B receive only, teleprinter/DSC
w = F1B/J2B, teleprinter/DSC
x = A1A, Morse, tape recorder
{ = A1A Morse, morse key/head set
| = F1C/F2C/F3C, facsimile machine
null for no information

NOTE 2 Frequencies to be in 100 Hz increments.

MF/HF telephone channels to have first digit 3 followed by ITU channel numbers with leading zeros as required.

MF/HF teletype channels to have first digit 4; the second and third digit frequency bands; and the fourth to sixth digits ITU channel numbers; each with leading zeros as required.

VHF channels to have first digit 9 followed by zero.

The next number is “1” indicating the ship station’s transmit frequency is being used as a simplex channel frequency, or “2” indicating the coast station’s transmit frequency is being used as a simplex channel frequency. The remaining three numbers are the VHF channel numbers with leading zeros as required.

NOTE 3 A variable number of frequency-mode pair fields is allowed up to a maximum of six pairs. Null fields are not required for unused pairs when less than six pairs are transmitted.

NOTE 4 Scanning frequency information may require the transmission of multiple messages. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1.

STN – Multiple data ID

This sentence is transmitted before each individual sentence where there is a need for the listener to determine the exact source of data in a system. Examples might include dual-frequency depth sounding equipment or equipment that integrates data from a number of sources and produces a single output.

$--STN, xx*hh<CR><LF>

Talker ID number, 00 to 99

TLB – Target label

Common target labels for tracked targets. This sentence is used to specify labels for tracked targets to a device that provides tracked target data (e.g. via the TTM – Tracked target message). This will allow all devices displaying tracked target data to use a common set of labels (e.g. targets reported by two radars and displayed on an ECDIS).

$--TLB,x.x,c--c,x.x,c--c,...x.x,c--c*hh<CR><LF>

Additional label pairs (see note 1)
Label assigned to target ‘n’ (see note 2)
Target number ‘n’ reported by the device.

NOTE 1 This message allows several target number/label pairs to be sent in a single message, the maximum sentence length limits the number of labels allowed in a message.

NOTE 2 Null fields indicate that no common label is specified, not that a null label should be used. The intent is to use a null field as a place holder. A device that provides tracked target data should use its ”local” label (usually the target number) unless it has received a TLB message specifying a common label.

TLL – Target latitude and longitude

Target number, name, position and time tag for use in systems tracking targets.

$--TLL, xx, llll.ll, a, yyyyy.yy, a, c--c, hhmmss.ss, a, a*hh<CR><LF>

Reference target (see note 2)
= R, null otherwise
Target status (see note 1)
UTC of data
Target name
Target longitude, E/W
Target latitude, N/S
Target number 00 – 99

NOTE 1 Target status:

L = Lost, tracked target has been lost

Q = Query, target in the process of acquisition

T = tracking

NOTE 2 Reference target: set to “R” if target is a reference used to determine own ship position or velocity, null otherwise.

***TTM – Tracked target message**

IMO Resolution A.820:1995 and MSC 64(67) Annex 4: Data associated with a tracked target relative to own ship's position.

$--TTM, xx, x.x, x.x, a, x.x, x.x, a, x.x, x.x, a, c--c, a, a, hhmmss.ss, a *hh<CR><LF>

Type of acquisition
A = Automatic
M = manual
R = reported
Time of data (UTC)
Reference target (see note 2) = R, null otherwise
Target status (see note 1)
Target name
Speed/distance units, K/N/S
Time to CPA, min., "-" increasing
Distance of closest-point-of-approach
Target course, degrees true/relative (T/R)
Target speed
Bearing from own ship, degrees true/relative (T/R)
Target distance from own ship
Target number, 00 to 99

NOTE 1 Target status:

L = Lost, tracked target has been lost

Q = Query, target in the process of acquisition

T = tracking

NOTE 2 Reference target: set to “R” if target is a reference used to determine own-ship position or velocity, null otherwise

TXT – Text transmission

For the transmission of short text messages. Longer text messages may be transmitted by using multiple sentences.

$--TXT,xx,xx,xx,c--c*hh<CR><LF>

Text message (see note 3)
Text identifier (see note 2)
Message number (see note 1), 01 to 99
Total number of messages (see note 1), 01 to 99

NOTE 1 Text messages may consist of the transmission of multiple messages all containing identical field formats. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1. For efficiency, it is recommended that null fields be used in the additional sentences, otherwise data is unchanged from the first sentence.

NOTE 2 The text identifier is a number, 01 to 99, used to identify different text messages.

NOTE 3 ASCII characters, and code delimiters if needed, up to the maximum permitted sentence length (i.e. up to 61 characters including any code delimiters).

Example: A GPS receiver sends a text alarm message (message ID 25, DR MODE - ANTENNA FAULT!) upon reverting to dead-reckoning mode due to an antenna fault (note the use of “^ 21” to indicate “!”, see 5.1.3).

$GPTXT,01,01,25,DR MODE-ANTENNA FAULT^21*38<CR><LF>

***VBW – Dual ground/water speed**

Water-referenced and ground-referenced speed data

$--VBW, x.x, x.x, A, x.x, x.x, A, x.x, A, x.x, A*hh<CR><LF>

Status (see note 2): stern ground speed, A = data valid, V = data invalid
Stern transverse ground speed (see note 1), knots
Status (see note 2): stern water speed, A = data valid, V = data invalid
Stern transverse water speed (see note 1), knots
Status (see note 2), ground speed, A = data valid, V = data invalid
Transverse ground speed (see note 1), knots
Longitudinal ground speed (see note 1), knots
Status (see note 2): water speed, A = data valid, V = data invalid
Transverse water speed (see note 1), knots
Longitudinal water speed (see note 1), knots

NOTE 1 Transverse speed: "-" = port, Longitudinal speed: "-" = astern.

NOTE 2 The status field shall not be a null field.

VDR – Set and drift

The direction towards which a current flows (set) and speed (drift) of a current.

$--VDR, x.x, T, x.x, M, x.x, N*hh<CR><LF>

Current speed, knots
Direction, degrees magnetic
Direction, degrees true

VHW – Water speed and heading

The compass heading to which the vessel points and the speed of the vessel relative to the water.

$--VHW, x.x, T, x.x, M, x.x, N, x.x, K*hh<CR><LF>

Speed, km/h
Speed, knots
Heading, degrees magnetic
Heading, degrees true

VLW – Distance travelled through the water

The distance travelled, relative to the water.

$--VLW, x.x, N, x.x, N*hh<CR><LF>

Distance since reset, nautical miles
Total cumulative distance, nautical miles

VPW – Speed measured parallel to wind

The component of the vessel's velocity vector parallel to the direction of the true wind direction. Sometimes called "speed made good to windward" or "velocity made good to windward".

$--VPW, x.x, N, x.x, M*hh<CR><LF>

Speed, m/s, "-" = downwind
Speed, knots, "-" = downwind

VTG – Course over ground and ground speed

The actual course and speed relative to the ground.

$--VTG, x.x, T, x.x, M, x.x, N, x.x, K,a*hh<CR><LF>

Mode indicator (see note)
Speed over ground, km/h
Speed over ground, knots
Course over ground, degrees magnetic
Course over ground, degrees true

NOTE Positioning system Mode indicator:
A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual input mode
S = Simulator mode
N = Data not valid
The positioning system Mode indicator field shall not be a null field.

WCV – Waypoint closure velocity

The component of the velocity vector in the direction of the waypoint, from present position. Sometimes called "speed made good" or "velocity made good".

$--WCV, x.x, N, c--c,a*hh<CR><LF>

Mode indicator (see note)
Waypoint identifier
Velocity component, knots

NOTE Positioning system Mode indicator:
A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual mode
S = Simulator mode
N = Data not valid
The positioning system Mode indicator field shall not be a null field.

WNC – Distance waypoint to waypoint

Distance between two specified waypoints.

$--WNC, x.x, N, x.x, K, c--c, c--c*hh<CR><LF>

FROM waypoint identifier
TO waypoint identifier
Distance, km
Distance, nautical miles

WPL – Waypoint location

Latitude and longitude of specified waypoint.

$--WPL, llll.ll, a, yyyyy.yy, a, c--c*hh<CR><LF>

Waypoint identifier
Waypoint longitude, E/W
Waypoint latitude, N/S

XDR – Transducer measurements

Measurement data from transducers that measure physical quantities such as temperature, force, pressure, frequency, angular or linear displacement, etc. Data from a variable number of transducers measuring the same or different quantities can be mixed in the same sentence. This sentence is designed for use by integrated systems as well as transducers that may be connected in a "chain" where each transducer receives the sentence as an input and adds on its own data fields before retransmitting the sentence.

$--XDR, a, x.x, a, c--c, ... a, x.x, a, c--c*hh<CR><LF>

Transducer "n" (see note 1)
Data, variable number of transducers
Transducer No. 1 ID
Units of measure, transducer No. 1 (see note 2)
Measurement data, transducer No. 1
Transducer type, transducer No. 1 (see note 2)

NOTE 1 Sets of the four fields "type-data-units-ID" are allowed for an undefined number of transducers. Up to "n" transducers may be included within the limits of allowed sentence length; null fields are not required except where portions of the "type-data-units-ID" combination are not available.

NOTE 2 Allowed transducer types and their units of measure are:

Transducer	Type field	Units	Comments
Temperature	C	C = degrees Celsius	
Angular displacement	A	D = degrees	"-" = anticlockwise
Linear displacement	D	M = metres	"-" = compression
Frequency	F	H = hertz	
Force	N	N = newtons	"-" = compression
Pressure	P	P = pascals, B = bar	"-" = vacuum
Flow rate	R	l = litres/s	
Tachometer	T	R = revolutions/min	
Humidity	H	P = per cent	
Volume	V	M = cubic metres	
Voltage	U	V = volts	
Current	I	A = amperes	
Switch or valve	S	None (null)	1 = ON, CLOSED; 0 = OFF, OPEN
Generic	G	None (null)	x.x = variable data

XTE – Cross-track error, measured

Magnitude of the position error perpendicular to the intended track line and the direction to steer to return to track.

$--XTE, A, A, x.x, a, N, a*hh<CR><LF>

Mode indicator (see notes 1 and 2)
Units, nautical miles
Direction to steer, L/R
Magnitude of cross-track error
Status: A = data valid V = LORAN-C cycle lock warning flag
Status (see note 2) A = data valid
V = LORAN-C blink or SNR warning,
V = general warning flag for other navigation systems when a reliable fix is not available

NOTE 1 Positioning system Mode indicator:

A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual input mode
S = Simulator mode
N = Data not valid

NOTE 2 The positioning system Mode indicator field supplements the positioning system Status fields (fields No. 1 and No. 2); the status fields shall be set to V = invalid for all values of indicator Mode except for A = Autonomous and D = Differential. The positioning system Mode indicator and Status fields shall not be null fields.

XTR – Cross-track error dead reckoning

Magnitude of the dead reckoned position error perpendicular to the intended track line and the direction to steer to return to track.

$--XTR, x.x, a , N*hh<CR><LF>

Units, nautical miles
Direction to steer, L/R
Magnitude of cross-track error

ZDA – Time and date

UTC, day, month, year and local time zone.

$--ZDA, hhmmss.ss, xx, xx, xxxx, xx, xx*hh<CR><LF>

Local zone minutes (see note 1), 00 to +59
Local zone hours (see note 1), 00 h to ±13 h
Year (UTC)
Month, 01 to 12 (UTC)
Day, 01 to 31 (UTC)
UTC

NOTE 1 Local time zone is the magnitude of hours plus the magnitude of minutes added, with the sign of local zone hours, to local time to obtain UTC. Local zone is generally negative for East longitudes with local exceptions near the International Date Line.

Example: At Chatham Is. (New Zealand) at 1230 (noon) local time on June 10, 1995:
$GPZDA,234500,09,06,1995,-12,45*6C<CR><LF>
In the Cook Islands at 1500 local time on June 10, 1995:
$GPZDA,013000,11,06,1995,10,30*4A<CR><LF>

ZDL – Time and distance to variable point

Time and distance to a point that might not be fixed. The point is generally not a specific geographic point but may vary continuously, and is most often determined by calculation (the recommended turning point for sailboats for optimum sailing to a destination, the wheel-over point for vessels making turns, a predicted collision point, etc.).

$--ZDL, hhmmss.ss, x.x, a*hh<CR><LF>

Type of point: C = collision
T = turning point
R = reference (general)
W = wheel-over
Distance to point, nautical miles
Time to point, 00 h to 99 h

ZFO UTC and time from origin waypoint

UTC and elapsed time from origin waypoint.

$--ZFO, hhmmss.ss, hhmmss.ss, c--c*hh<CR><LF>

Origin waypoint ID
Elapsed time, hh = 00 to 99
UTC of observation

ZTG – UTC and time to destination waypoint

UTC and predicted time-to-go to destination waypoint.

$--ZTG, hhmmss.ss, hhmmss.ss, c--c*hh<CR><LF>

Destination waypoint ID
Time-to-go, hh = 00 to 99
UTC of observation

7 Applications

7.1 Example sentence

These examples are intended as samples of correctly constructed sentences. They are representative samples only and show part of the wide range of acceptable variations possible with sentences. They shall not necessarily be used as templates for sentences.

7.1.1 Example 1 – LORAN-C latitude/longitude

This example gives present position in latitude/longitude, as determined by LORAN-C. The three character mnemonic in the address, GLL, indicates that the data is present position in latitude/longitude. The time (UTC) of the position fix is 09 h, 13 min and 42 s. Decimal seconds are not available and the decimal point is optionally omitted. There are no warning flags set in the navigation receiver as indicated by status A.

$LCGLL, 4728.31, N, 12254.25, W, 091342, A,A*4C<CR><LF>

Sentence terminator
Checksum 4C HEX
Mode indicator: A = autonomous mode
Receiver status: no warnings
Time of position fix
Units designator (west)
Longitude: 122°, 54,25′
Units designator (north)
Latitude 47°, 28,31′
Address: LC = LORAN-C, GLL = present position
Start of sentence

7.1.2 Example 2 LORAN-C arrival alarm

This example illustrates arrival alarm data. The mnemonic code for arrival alarm is AAM. In this case the address field is "LCAAM" for LORAN-C arrival alarm. The first data field shows "V" indicating the radius of the arrival circle HAS NOT been entered, the second data field is "A" showing that the perpendicular to the course line, at the destination, HAS been crossed. The third and fourth fields show the radius and units of the destination waypoint arrival circle ".15, N" for 0,15 nautical miles. Data field 5 is the waypoint identifier field of valid characters.

$LCAAM,V, A, .15, N, CHAT-N6*56<CR><LF>

Sentence terminator
Checksum 56 HEX
Identifier for waypoint "CHAT-N6"
Units of arrival circle, nautical miles
Radius of arrival circle, 0,15
Status: perpendicular has been crossed
Status: arrival circle has not been entered
Address: LC = LORAN-C, AAM = Arrival alarm
Start of sentence

7.1.3 Example 3 – Proprietary sentence

A proprietary sentence has the following general format:

79 character sentence or less

$Paaa--- *hh <CR><LF>

End of sentence
Data, 72 character max.
Checksum
Three characters from manufacturer's mnemonic code
Proprietary sentence identifier
Start of sentence

A specific example will have little meaning to someone other than the particular manufacturer that designed the sentence:

$PSRDA003[470738][1224523]???RST47, 3809, A004 *47<CR><LF>

End of sentence
Checksum 47 HEX
Any series of value (non-reserved)
Characters of manufacturer's choice
Manufacturer's unique assigned code
Proprietary sentence identifier
Start of sentence

7.1.4 Example 4 – RMA examples

The following group of sentences show a typical progression of output data as a LORAN-C receiver acquires stations:

a) $LCRMA, V,,,,,14162.8,,,,,,N *6F<CR><LF>

Data invalid, only one TD acquired. Fields where data is not yet available are null fields.

b) $LCRMA, V,,,,,14172.3, 26026.7,,,,,N *4C<CR><LF>
   Two TDs acquired but not settled, data invalid.
c) $LCRMA, A,,,,,14182.3, 26026.7,,,,,A *5B<CR><LF>
   Data valid, two TDs cycled but latitude/longitude not yet calculated.
d) $LCRMA, A,4226.26,N,07125.89,W,14182.3,26026.7,8.5,275.,14.0,W,A*05<CR><LF>
   Normal operation.
e) $LCRMA,V,4226.26,N,07125.89,W,14182.3,26026.7,8.5,275.,14.0, W,N*1D<CR><LF>
   Data invalid, potential LORAN-C problem
f) $LCRMA,A,4226.265,N,07125.890,W,14172.33,26026.71,8.53,275.,14.0,W,D*3B<CR>
g) <LF>
   LORAN-C operating in high resolution mode.

7.1.5 Example 5 – FSI examples

The following sentences show typical applications for remote control of radiotelephones:

a) $CTFSI, 020230, 026140, m, 0*14<CR><LF
   Set transmitter 2 023 kHz, receiver 2 614 kHz, mode J3E, telephone, standby.
b) $CTFSI, 020230, 026140, m, 5*11<CR><LF>
   MF/HF radiotelephone set transmit 2 023 kHz, receive 2 614 kHz, mode J3E, telephone, medium power.
c) $CTFSI,, 021820, o, *2D<CR><LF>
   Set receiver 2 182 kHz, mode H3E, telephone.
d) $CDFSI, 900016, , d, 9*08<CR><LF>
   Set VHF transmit and receive channel 16, F3E/G3E, simplex, telephone, high power.
e) $CTFSI, 300821, , m, 9*17<CR><LF>
   Set MF/HF radiotelephone to telephone channel 821, e.g. transmit 8 255 kHz, receive 8 779 kHz, mode J3E, telephone, high power.
f) $CTFSI, 404001, , w, 5*08<CR><LF>
   Set MF/HF radiotelephone to teletype channel 1 in 4 MHz band e.g. transmit 4 172,5 kHz, receive 4 210,5 kHz, mode F1B/J2B, teleprinter, medium power.
g) $CTFSI, 416193, , s, 0*00<CR><LF>
   MF/HF radiotelephone set to teletype channel 193 in 16 MHz band e.g. transmitter 16 784,5 kHz, receiver 16 902,5 kHz, mode F1B/J2E ARQ, telex/teleprinter, standby.
h) $CTFSI, 041620, 043020, |, 9*0A<CR><LF>
   Set MF/HF radiotelephone transmit 4 162 kHz, receive 4 302 kHz, mode F1C/F2C/F3C, facsimile machine, high power.
i) $CXFSI, , 021875, t, *3A<CR><LF>
   Scanning receiver set to 2 187,5 kHz, mode F1B/J2B, receive only, teleprinter/DSC.

7.1.6 Example 6 – MSK / MSS examples

These two examples have been added:

GPS receiver (GP) query sentences to a data receiver (CR):

a) request for configuration information:
   $GPCRQ,MSK*2E<CR><LF>

reply could be:

$CRMSK,293.0,M,100,A,10,1*6F<CR><LF>

b) request for signal strength, S/N ratio:

$GPCRQ,MSS*36<CR><LF>

reply could be

$CRMSS,50,17,293.0,100,1*55<CR><LF>

7.2 Examples of receiver diagrams

The illustrative diagrams in figures 3 and 4 show the example structure of two opto-isolator based listener circuits that offer overvoltage, reverse voltage and power dissipation protection for the opto-isolator and serve to limit the current drawn from the line.

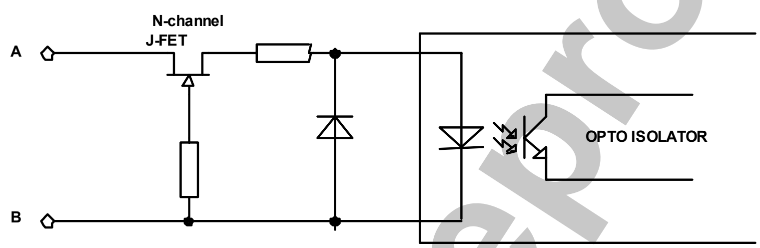

Figure 3 – Example 1, J-FET, N channel, opto-isolator based listener circuit

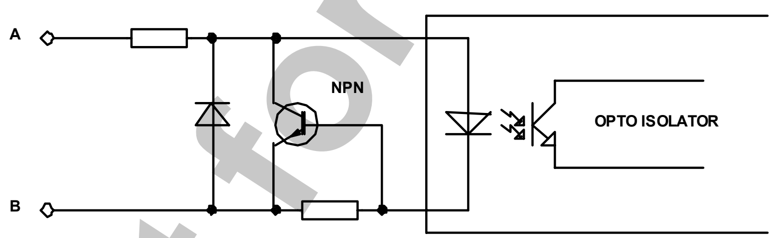

Figure 4 – Example 2, NPN opto-isolator based listener circuit

Annex A
(informative)

Minimum required sentences for equipment with digital interfaces conforming to IMO resolutions and ITU recommendations and their association with the relevant IEC and ISO standards

NOTE If this Annex and an equipment standard differs, the equipment standard shall take precedence.

Table A.1 – IMO Resolutions – Navigation – recommended sentences

Equipment	Talker	Listener
Magnetic compass	HDG	–
Electromagnetic compass	HDG, HDT	–
Gyro compass	HDT	VBW,GLL,GNS,DTM
EPA	RSD,OSD	HDG,HDT,VBW,GLL, GNS,DTM
ATA	RSD,TTM,OSD	HDT,GLL,GNS,DTM, VBW
ARPA	RSD,TTM,OSD	HDT,GLL,GNS,DTM, VBW
SDME water tracking log	VBW, VLW	–
bottom tracking log	VBW	–
R.O.T.I	ROT	–
Loran–C / Chayka receiver	GLL, DTM	–
Decca receiver	GLL, DTM	–
GPS receiver	GNS, DTM, ZDA	–
GLONASS receiver	GNS, DTM, ZDA	–
DGPS receiver	GNS, DTM, ZDA	
DGLONASS receiver	GNS, DTM, ZDA MSK, MSS, MSK	MSS, MSK
Heading control system	HTD	HDT, VBW, HTC
ECDIS	RTE, WPL	GGA, GLL, GNS, DTM ZDA, HDT, VBW, VTG
INS (Integrated Navigation system)	GLL, DTM, VTG, ZDA	GLL, GNS, DTM, ZDA, HDT, VBW, VTG, RTE, WPL
Rudder angle indicator	RSA	–
Transducer	XDR	–
Wind sensor	MWV	–
Water temperature	MTW	–
Engine revolution	RPM	–

Table A.2 – IMO Resolutions and IEC/ISO Navigation standards

Equipment	IMO Resolution	IEC/ISO Standards
Magnetic compass	A.382	ISO 449, ISO 2269
Electromagnetic compass	MSC.86(70) annex 2	ISO 11606*
Gyro compass	A.424 A.821- HSC	ISO 8728 ISO/IEC 16328*
Radar	MSC.64(67) annex 4 A.820 – HSC	IEC 60936-1 IEC 60936-2
EPA	MSC.64(67) annex 4	IEC 60872-3*
ATA	MSC.64(67) annex 4	IEC 60872-2
ARPA	A.823	IEC 60872-1
Echo sounder	A.224	ISO 9875
SDME	A.824	IEC 61023
R.O.T.I	A.526	
Loran-C / Chayka receiver	A.818	IEC 61075
GPS receiver	A.819	IEC 61108-1*
GLONASS receiver	MSC 53(66)	IEC 61108-2
DGPS receiver	MSC.64(67) annex 2	IEC 61108-4*
DGLONASS receiver	MSC.64(67) annex 2	IEC 61108-4*
Heading control system Track control system	MSC.64(67) annex 3 A.822 – HSC MSC.70(69) annex 2	IEC/ISO 11674* IEC/ISO 16329* IEC/ISO 62065*
ECDIS	A.817, MSC.86(70) annex 4	IEC 61174
INS	MSC.86(70) annex 3	IEC 61924*
Rudder angle indicator	None	None
Transducer	None	None
Voyage data recorder	A.861	IEC 61996*
Wind sensor	None	None
Water temperature	None	None
Engine revolution	None	None
* Under development or revision.		

Table A.3 – IMO Resolutions – Radiocommunication – recommended sentences

Equipment	Talker	Listener
406 MHz satellite EPIRB [1)]	–	GLL, GNS
DSC equipment [2)]	DSC, FSI, SFI [3)]	DSC, FSI, GLL, GNS, ZDA
Inmarsat-C SES	–	GLL, GNS, ZDA
Inmarsat-E satellite EPIRB [4)]	–	GLL, OSD [5)] or VTG [5)], GNS, ZDA [5)]
VHF radio installation	FSI [6)]	DSC [7)], FSI [6)], GLL [8)], GNS [8)], ZDA [8)]
DSC watchkeeping receiver	FSI [9)]	SFI [6)]
MF/HF radio installation	FSI [6), 10)], SFI [3)]	DSC [7)], FSI [6)], GLL [8)], GNS SFI [10)], ZDA [8)]
Inmarsat-B SES [11)]	–	GLL, GNS, ZDA
NBDP radiotelex	FSI [10), 11)]	FSI [12)], SFI [10)]
Inmarsat-A SES [11)]	–	GLL, GNS, ZDA

1) Only required when designed for optional "long message" transmission.

2) Only required for stand-alone DSC equipment designed to control associated VHF or MF/HF radio installations or DSC watchkeeping receiver.

3) Only required when designed to control DSC watchkeeping receiver.

4) Only required when facilities are not included for automatic position updating after activation.

5) Sentence optional.

6) Only required when designed for control by an external controller.

7) Only required when designed for operation with external DSC equipment.

8) Not required when designed for operation with external DSC equipment.

9) Only required for multiple-frequency and scanning receivers without read-out.

10) Only required when designed with an integrated scanning receiver to be controlled by an external controller.

11) Sentences recommended for new designs.

12) Only required when designed for control by an associated MF/HF radio installation.

Table A.4 – IMO resolutions, and ITU recommendations and IEC standards for radiocommunication (including INMARSAT and COSPAS-SARSAT)

	1988 SOLAS	IMO resolution	ITU-R recommendation	INMARSAT and COSPAS-SARSAT	IEC standard*
1	Primary systems				
1.1	VHF radio installation DSC RT	A.803 A.385 A.524	 493, 541, 689 		61097-7 61097-3 61097-7
1.2	MF radio installation DSC RT	A.804 A.334 A.806	 493, 541 		61097-9 61097-3 61097-9
1.3	MF/HF radio installation DSC RT NBDP	A.806 A.804 A.334 A.806	 493, 541 491, 492, 625		61097-9 61097-3 61097-9 61097-11
1.4	IMMARSAT ship earth station	A.570 A.807 A.808		 SDM 	 61097-4 61097-10
2	Secondary means of alerting				
3	Facilities for reception of maritime safety information				
3.1	NAVTEX receiver (518 kHz)	A.525	540, 625		61097-6
3.2	EGC receiver	A.664		SDM	61097-4
3.3	HF NBDP receiver	A.700	491, 492, 625, 688		61097-11
4	Satellite E.P.I.R.B.				
4.1	COSPAS-SARSAT (406 MHz)	A.662	633	C/S T001	61097-2
4.2	INMARSAT	A.812	632	SDM	61097-5
5	VHF E.P.I.R.B.	A.805	693		
6	Ship's radar transponder (SART)	A.802	628		61097-1
7	RT watch receiver (2 182 kHz)	A.383			
8	RT alarm signal (2 182 kHz)	A.421	219		
9	VHF portable (survival craft)	A.809			61097-12
10	General requirements	A.694			60945
11	Reserve source of energy	SOLAS IV-13			61097-14
* The IEC 61097 series is currently being developed. The bibliography includes all those parts published.					

Annex B
(informative)

Glossary

NOTE The definitions which follow are included for additional understanding of this standard, but may not command universal acceptance.

accuracy: In navigation, measure of the error between the point desired and the point achieved, or between the position indicated by measurement and the true position (compare with **precision**).

address field: For sentences in this standard, fixed length field following the beginning sentence delimiter "$" (HEX 24); for approved sentences, composed of a two-character talker identifier and a three-character sentence formatter; for proprietary sentences, composed of the character "P" (HEX 50) followed by a three-character manufacturer identification code.

additional secondary factor: in LORAN-C, a correction in addition to the secondary phase factor correction for the additional time (or phase delay) for transmission of a low-frequency signal over a composite land-sea path when the signal transit time is based on the free-space velocity.

apparent wind: (see **relative wind**).

approved sentence: Sentence which is listed in this standard and annexes.

arrival alarm: Alarm signal issued by a voyage tracking unit which indicates arrival at, or at a pre-determined distance from, a waypoint (see **arrival circle**).

arrival circle: Artificial boundary placed around the destination waypoint of the present navigation leg, the entering of which will signal an arrival alarm.

arrival perpendicular: Crossing of the line which is perpendicular to the course line and which passes through the destination waypoint.

azimuth: Horizontal direction of a celestial point from a terrestrial point, expressed as the angular distance from a reference direction, usually measured from 000° at the reference direction clockwise through 359°.

ASCII: American standard code for information interchange. A seven-bit wide serial code describing numbers, upper and lower case alphabetical characters, special and non-printing characters. See American National Standards Institute (ANSI) ANSI X 3.15, ANSI X 3.16 and ANSI X 3.4.

atomic time: Time obtained by counting the cycles of a signal in resonance with certain kinds of atoms.

autopilot: *Refer to* **heading control system**.

bearing: Horizontal direction of one terrestrial point from another, expressed as the angular distance from a reference direction, usually measured from 000° at the reference direction clockwise through 359°.

beaufort wind scale: Numerical scale for indicating wind speed. Beaufort numbers (or forces) range from force 0 (calm) to force 12 (hurricane).

blink: In LORAN-C, signal used to indicate that a station is malfunctioning. Intended to prevent use of that signal for navigation.

checksum: For this standard, a mandatory validity check performed on the data contained in the sentences, calculated by the talker, appended to the message, then re-calculated by the listener for comparison to determine if the message was received correctly.

communication protocol: Method established for message transfer between a talker and a listener which includes the message format and the sequence in which the messages are to be transferred. Also includes the signalling requirements such as baud rate, stop bits, parity, and bits per character.

course: Horizontal direction in which a vessel is steered or intended to be steered, expressed as angular distance from north, usually from 000° at north, clockwise through 359°. Strictly, the term applies to direction through the water, not the direction intended to be made good over the ground (see **track**). Differs from **heading**.

course over ground (COG): Term used to refer to the direction of the path over ground actually followed by a vessel (a misnomer, in that courses are directions steered or intended to be steered through the water with respect to a reference meridian).

cross track error (XTE): Distance from the vessel's present position to the closest point on a line between the origin and destination waypoints of the navigation leg being travelled.

cycle lock: In LORAN-C, comparison, in time difference, between corresponding carrier cycles contained in the rise times of a master and slave station pulse is called cycle match. This value when refined to a determination of the phase difference between these two cycles results in cycle lock (see also **envelope-to-cycle distortion**).

data field: In a sentence, field which contains a data value.

dead reckoning: Process of determining the position of a vessel at any instant by applying to the last well-determined position (point of departure or subsequent fix) the run that has since been made, usually based on the recent history of speed and heading measurements.

DECCA chain: Group of associated stations of the DECCA Navigator system. A DECCA chain normally consists of a master and three slave stations. Each slave station is called by the colour of an associated pattern of hyperbolic lines as printed on the chart, i.e. red slave, green slave, purple slave.

DECCA navigator system: Short-to-medium range low frequency (70 kHz to 130 kHz) radionavigation system by which a hyperbolic line of position of high accuracy is obtained. The system is an arrangement of fixed, phase-locked, continuous wave transmitters operating on harmonically related frequencies and special receiving equipment located on a vessel. The operation of the system depends on phase comparison of the signals from the transmitters brought to a common comparison frequency with the receiver.

delimiter: In this standard, character or characters used to separate fields or sentences. The following delimiters are used in this standard:

Field delimiters:

– ASCII "$" (HEX 24) for address field
– ASCII "," (HEX 2C) for data fields

– ASCII "*" (HEX 2A) for checksum field

Sentence delimiters

– carriage return <CR> and line feed <LF> (HEX 0D0A)

NOTE <CR><LF> is not required preceding the first sentence transmitted.

depth sounder: Instrument which determines the depth of water by measuring the time interval between the emissions of a sound and the return of its echo from the bottom.

destination: Immediate geographic point of interest to which a vessel is navigating. It may be the next waypoint along a route of waypoints or the final destination of a voyage.

deviation: Angle between the magnetic meridian and the axis of a compass card, expressed in degrees east or west to indicate direction in which the northern end of the compass card is offset from magnetic north.

DGNSS: Differential GNSS, the use of GNSS measurements, some or all of which are differentially corrected.

DGPS: Differential GPS, the use of GPS measurements which are differentially corrected.

Doppler speed log: Instrument which measures the relative motion between a vessel and the reflective sea bottom (for bottom return mode) or suspended particulate matter in the seawater itself (for water return mode) by measuring the frequency shifts between a transmitted and subsequently echoed acoustic or electromagnetic signal.

drift: Speed of a current.

echo sounder: See **depth sounder**.

envelope-to-cycle distortion (ECD): Time relationship between the phase of the LORANC carrier and the time origin of the envelope waveform.

field: In this standard, character or string of characters immediately preceded by a field delimiter (see **delimiter**).

fixed field: In this standard, field in which the number of characters is fixed. For data fields, such fields are shown in the sentence definitions with no decimal point. Other fields which fall into this category are the address field and the checksum field (if present).

geoid: Surface along which the gravity potential is equal everywhere (equipotential surface) and to which the direction of gravity is always perpendicular.

geometric dilution of precision (GDOP): Value representing all geometric factors that degrade the accuracy of a position fix which has been derived from a navigation system.

global navigation satellite system (GNSS): Any single or combined satellite navigation system. Currently the options are: GPS, GLONASS and combined GPS/GLONASS.

GLONASS: An all-weather, continuous satellite navigation system, maintained by the Russian Space Forces. Normally composed of 24 satellites in 3 orbital planes with 8 satellites in each plane. The spacing of satellites in orbit is arranged so that a minimum of 4 satellites will be in view to users wordwide to provide position dilution of position (PDOP) of 6 or less.

global positioning system (GPS): All-weather, continuous satellite navigation system. The fully deployed operational system is intended to provide highly accurate position and velocity information in three dimensions and precise time and time interval on a global basis, to an unlimited number of authorized users.

great circle: Intersection of the surface of a sphere and a plane through its centre.

great circle chart: Chart on which a great circle appears as a straight line or approximately so.

great circle direction: Horizontal direction of a great circle, expressed as angular distance from a reference direction.

group repetition interval (GRI): (of a particular LORAN-C chain) Specified time interval for all stations of the chain to transmit their pulse groups. For each chain a minimum group repetition interval is selected of sufficient duration to provide time for each station to transmit its pulse group and additional time between each pulse group so that signals from two or more stations cannot overlap in time anywhere within the coverage area.

gyrocompass: Compass having one or more gyroscopes as the directive element, and which is north-seeking. Its operation depends upon four natural phenomena: gyroscopic inertia, gyroscopic precession, the earth's rotation and gravity.

gyropilot: Automatic device for steering a vessel by means of control signals received from a gyrocompass (see heading control system).

gyroscope: Rapidly rotating mass free to move about one or both axes perpendicular to the axis of rotation and to each other.

heading: Horizontal direction in which a ship actually points or heads at any instant, expressed in angular units from a reference direction, usually from 000° at the reference direction clockwise through 359°. (See **true heading** and **magnetic heading**).

heading control system: Automatic device for steering a vessel so as to maintain heading in an intended direction. Mechanical means are used to steer the rudder. A radio navigation system is often connected to correct for track errors, or to select new destinations.

heading to steer: Difference between the bearing to destination (from present position) and track made good, applied to the bearing to the destination to produce a heading that will guide the vessel to the destination.

horizontal dilution of precision (HDOP): Similar to GDOP, except elevation factors are ignored.

keel: Longitudinal timber or plate extending along the centre of the bottom of a ship and often projecting from the bottom.

line of position (LOP): In LORAN or DECCA navigation systems, vector obtained by measurement of the time difference between the receipt of the master and slave signals which is then used to select a corresponding LOP from a chart or table. Two or more intersecting LOPs are required to obtain a position fix.

listener: In this standard, recipient of messages across an interconnecting link.

log: Instrument for measuring the speed or distance or both travelled by a vessel.

LORAN: General designation of one group of radionavigation systems by which a hyperbolic line of position is determined through measuring the difference in the times of reception of synchronized pulse signals from two fixed transmitters.

magnetic bearing: Bearing relative to magnetic north; compass bearing corrected for deviation.

magnetic heading: Heading relative to magnetic north.

manufacturer identification code: In this standard, three character manufacturer identifier, usually an acronym derived from the company name, for use by a manufacturer as part of the address field in formulation of proprietary sentences.

Mercator map projection: Conformal cylindrical map projection in which the surface of a sphere or spheroid, such as earth, is conceived as developed on a cylinder tangent along the equator. Meridians appear as equally spaced vertical lines and parallels as horizontal lines drawn farther apart as the latitude increases, such that the correct relationship between latitude and longitude scales at any point is maintained. Also known as Mercator map projection.

navigation leg: Portion of a voyage upon which the vessel currently travels. Each leg consists of two waypoints, an origin, a destination, and a line between them, upon which the vessel travels.

null field: Indicates that data is not available for the field. Indicated by two ASCII commas, i.e. ",," (HEX 2C2C), or, for the last data field in a sentence, one comma followed by the checksum delimiter "*" (HEX 2A).

NOTE The ASCII null character (HEX 00) is not to be used for null fields.

one-way communication protocol: Protocol established between a talker and a listener in which only the talker may send messages (compare to **two-way** communication protocol).

origin waypoint: Starting point of the present navigation leg.

precision: Measure of how close the outcome of a series of observations or measurements cluster about some estimated value of a desired quantity, such as the average value of a series of observations of a quantity. Precision implies repeatability of the observations within some specified limit and depends upon the random errors encountered due to the quality of the observing equipment, the skill of the observer and randomly fluctuating conditions such as temperature, pressure, refraction, etc. (compare with **accuracy**).

proprietary sentence: Sentence to be sent across the interconnecting link which is not included in the list of approved sentences of this standard. All proprietary sentences sent over the interconnecting link contain a unique talker identifier which begins with a "P" (HEX 50) followed by a three-character manufacturer identification code.

relative bearing: Bearing relative to heading or to the vessel.

relative wind: The speed and relative direction from which the wind appears to blow with reference to a moving point (also called **apparent wind**).

rhumb line: Line on the surface of the earth making the same oblique angle with all meridians. A rhumb line is a straight line on a rhumb (or Mercator) projection.

rhumb direction: The horizontal direction of a rhumb line, expressed as angular distance from a reference direction. Also known as Mercator direction (see **Mercator** map projection).

RMa sentence: Recommended minimum acceptable (RMa) sentence, a composite sentence recommended by this standard to ensure interoperability between talkers and listeners and to ensure that all data considered necessary for navigation is sent by a particular navigation unit.

route: Planned course of travel, usually composed of more than one navigation leg.

route system: Any system of one or more routes and/or routing measures aimed at reducing the risk of casualties during a voyage which may include such items as traffic separation schemes, recommended tracks, restricted areas, inshore traffic zones, etc.

semi-fixed field: Data fields having a base other than 10, but using base 10 to express precision of the final term (such as minutes expressed as units with a decimal trailer instead of seconds in a base 60 field, or seconds expressed with a decimal trailer).

selected waypoint: Waypoint currently selected to be the point towards which the vessel is travelling. Also called **"TO" waypoint**, **destination** or **destination waypoint**.

sentence formatter: In this standard, three-character sentence identifier which follows the talker identifier and is included as part of the address field. The sentence formatters are an integral part of the sentence definitions provided by this standard and annexes.

set: Direction towards which a current flows.

signal-to-noise ratio (SNR): Ratio of the magnitude of a signal to that of the noise (interference), often expressed in decibels.

speed log: Instrument for measuring a vessel's speed through water and/or speed over ground. A single axis speed log normally measures speed along the longitudinal (fore/aft) axis of the vessel, while a dual axis speed log measures speed along the transverse (port/starboard) axis as well (see also **doppler speed log**).

speed made good: Adjusted speed which takes into account factors such as drift and wind speed. Can be estimated or computed by a navigation receiver.

speed over ground (SOG): Speed of a vessel along the actual path of travel over the ground.

talker: Originator of messages across a link.

talker identifier: First two characters following the "$" (HEX 24) in a sentence (address characters 1 and 2); selected from Table 4.

time difference (TD): In LORAN-C, time difference measured from the time of reception of the master station signal to the time of reception of the slave station signal.

track: Intended or desired horizontal direction of travel with respect to the earth. The track expressed in degrees of the compass may differ from the course due to allowances made in the course for such factors as sea and weather conditions in order to resume the desired track (see **track made good**).

track made good: Single resultant direction from a point of departure to a point of arrival at any given time.

transducer: Device that converts one type of energy to another, such as a loudspeaker that changes electrical energy into acoustical energy.

true bearing: Bearing relative to true north; compass bearing corrected for compass error.

true heading: Heading relative to true north.

two-way communication protocol: Protocol established between a talker and a listener in which the listener may also issue requests to the talker when required (compare to **one-way** communication protocol).

UART: Universal asynchronous receiver/transmitter which produces an electrical signal and timing for transmission of data over a communications path, and circuitry for detection and capture of such data transmitted from another UART.

universal time coordinated (UTC): Time scale based on the rotation of the earth which is disseminated by most broadcast time services (compare with **atomic time**).

variable field: Data field which may or may not contain a decimal point and which may vary in precision following the decimal point depending on the requirements and the accuracy of the measuring device (talker).

variation: Angle between the magnetic and geographic meridians at any place, expressed in degrees and minutes east or west to indicate the direction of magnetic north from true north.

voyage data recorder (VDR): Device for automatically logging key operating parameters of a vessel and maintaining a secure record for subsequent analysis in the event of a collision, sinking or other incident.

waypoint: Reference point on a track.

wide area augmentation system (WAAS): An augmentation to GNSS which uses geostationary satellites to broadcast GNSS integrity and correction data and additional ranging signals.

Annex C
(normative)

Guidelines for methods of testing and required test results

C.1 General

C.1.1 The EUT (equipment under test), including all necessary test equipment shall be set up and checked to ensure that it is operational before testing commences. The manufacturer shall provide sufficient technical documentation of the EUT.

C.1.2 The manufacturer shall provide, unless otherwise agreed, test reports according to this annex.

C.1.3 Where appropriate, tests against different clauses of this annex may be carried out simultaneously.

C.2 Definition of environmental conditions for the tests

The tests shall be carried out at normal environmental conditions as defined in 5.2.1 of IEC 60945. Only test C.4.5 shall be performed at the environmental conditions as defined in IEC 60945, Table 3 for the class of the EUT.

C.3 Examination of the manufacturer's documentation.

C.3.1 Check for completeness according to IEC 61162-1.

C.3.2 Check the availability of the defined minimum sentences on the EUT (receiving and transmitting).

C.3.3 Check of documentation of approved and proprietary sentences:

– approved sentences for conformity with the standard;
– proprietary sentences for conformity with the standard and the documentation of the manufacturer;
– fields that are required or acceptable to a listener;
– noted unused fields to a talker;
– transmission interval for each sentence.

C.3.4 Check of used Talker – ID’s.

C.3.5 Check of Hardware requirements:

– output drive capability of talker;
– load requirement as listener;
– current software and hardware revision if this is relevant to the interface port selection and pin configuration;
– electrical isolation of the input circuits for compliance with IEC 60945;
– description or schematic of listener receive and talker driver circuits, citing actual components and devices used, including connector type and part number.

C.4 Test of hardware

C.4.1 (3.5.2) Interface units

For compatibility of the hardware, standard tests shall be used as defined in ITU-T X.27/V.11 for all transmitter interface units where compliance with ITU-T X.27/ V.11 is not documented.

C.4.2 (3.5.3) Ability of the input circuits to work with limited current

For testing that the receiving capability is not degraded by a minimum supply of 2 mA at a differential voltage of 2 V.

The receiver unit shall be connected to a data-source with a differential voltage of 2 V and a current limitation of 2 mA. The data source shall transmit appropriate sentences for this EUT. All sentences shall be received and detected without any errors or degradation.

C.4.3 (3.5.4) Check of electrical isolation

Check in the manufacturer’s documentation that the isolation of the receiver between signal line ”A”, return line ”B”, or shield and ships ground or power fullfil the requirements of 6.7 of IEC 60945.

C.4.4 (3.5.5) Ability of input circuits to withstand maximum voltage on the bus

Between the connectors ‘A’ and ‘B’ of the interface a voltage of 15 V shall be applied for at least 1 min. This test shall be carried out with both polarities of applied test voltage. After all tests the function of the interface shall be checked for any malfunction or damage.

C.4.5 Test arrangement for performance tests according to IEC 60945

The following test shall be carried out for testing capability of interconnection during the temperature tests defined in IEC 60945. Where the equipment manufacturer specifies a temperature range outside that specified in IEC 60945, the manufacturer’s specification shall be employed.

To test the transmitting interface of the EUT, connect it to a reference-receiving interface that complies with IEC 61162-1. To test the receiving interface of the EUT, connect it to a reference transmitting interface as defined in C.4.2. The reference equipment shall be outside the climatic chamber. The transmitting interface shall transmit a sequence of appropriate sentences and the receiving interface shall receive and detect these sentences without any errors or degradation. The check of the result can be carried out directly or indirectly at the receiving unit.

C.4.6 Test under maximum interface workload

After activating all ports of the EUT with the maximum number of sentences to be transmitted and/or received, the performance of the EUT shall not be degraded in any way.

At least one receiver input not used to perform the primary function of the EUT shall be connected to a data source transmitting continuously a set of approved sentences with a channel limit of 80 % to 90 %. Only one of these sentences shall be usable for the EUT. The test shall be carried out for 30 minutes. The EUT may give an alarm for a minor function not supported by the selected sentence, but the main function of the EUT shall be operational without any degradation.

C.4.7 Test against corrupted data at an interface

To test the capability against corrupted data of the EUT sent out by a equipment after a system failure.

One receiver input not used to perform the primary function of the EUT shall be connected to a data source transmitting continuously unsorted text.

The test shall be carried out for a sufficient time to ensure that the primary function of the EUT works in a reliable manner. The EUT may give an alarm for the minor function assigned to the selected input. The main function should not be not supported by the selected sentence but the main function of the EUT shall be operational without any degradation.

C.4.8 Test under long term conditions

For testing the capability of the EUT working constantly.

The EUT shall be connected to transmitting sources as defined by the manufacturer for normal operation. This test shall be carried out for 30 min, and all data transmitted by the EUT shall be recorded and analysed for corruption against this standard.

C.4.9 (5) Protocol test of the interface of the EUT

C.4.9.1 Data strings transmitted by the EUT

By altering the parameters of the EUT, appropriate data strings shall be transmitted.

These data strings are received by test equipment which is able to display the sentences.

a) Test of conformity with the manufacturer's documentation and IEC 61162-1.

b) Test of status accuracy for all status and operation mode indications.

c)[1] Test of data accuracy corresponding with the status information and the selected operation mode.

d)[2] Test of checksum accuracy

e) Test of transmitting intervals (if necessary)

C.4.9.2 Data strings received by the EUT

Artificially generated data strings with various content and formatting shall be sent to the EUT. These are generated by the above-mentioned means and in accordance with the manufacturer's documentation.

a)[3] Test of correct evaluation of the data.

b)[3] Test of correct evaluation of all status indications and the selected operation mode.

c)[5] Test of adequate reaction in case of incorrectness corresponding with the status information and the selected operation mode.

d)[4] Test of correct evaluation of the checksum.

e)[5] Test of break of data line.

f) Test of the required receiving intervals (if necessary).

[1] Refer to Table C.1 as an example.

[2] Refer to Table C.2 as an example.

[3] Refer to Table C.3 as an example.

[4] Refer to Table C.4 as an example.

[5] Refer to Table C.5 as an example.

Where the transmitted or received data corresponds to that shown on the display of the EUT, this data shall be compared directly with that sent by the test equipment.

Otherwise, if the data is altered or combined with other data so that direct access and comparison is not possible, parts of the test shall be adapted appropriately such that indirect comparison is possible.

Table C.1 – Example – Data string GGA sent by the EUT to the test receiver (listener)

Field	Field label (and operational state)	Value sent from EUT in the data sentence	Received value at the test receiver
1	UTC of position	Value at the EUT	
2 + 3	Latitude, N/S	Value at the EUT	
4 + 5	Longitude, E/W	Value at the EUT	
6	GPS quality indicator – Fix not available or invalid (has to be set at EUT)	0	
	GPS quality indicator – GPS SPS mode, fix valid (has to be set at EUT)	1	
	GPS quality indicator – Differential GPS, SPS mode, fix valid (has to be set at EUT)	2	
	GPS quality indicator – GPS PPS mode, fix valid	3	
	Real time kinematic, satellite system used in RTK mode with fixed integers	4	
	Float RTK, satellite system used in RTK mode with floating integers	5	
	Estimated (dead reckoning) data	6	
	Manual input mode	7	
	Simulator mode	8	
7	Number of satellites in use, 00-12, may be different from the number in view	Value at the EUT	
8	Horizontal dilution of precision (HDOP)	Value at the EUT	
9	Antenna altitude above/below mean-sea-level (geoid)	Value at the EUT (always in metres, also when the displayed value is not in this unit)	
10	Units of antenna altitude, m	"M", also when value at the EUT not shown in metres	
11	Geoidal separation	Value at the EUT (always in metres, also when the displayed value is not in this unit)	
12	Units of geoidal separation, m	"M", also when value at the EUT not shown in metres	
13	Age of differential GPS data	Value at the EUT if differential mode, otherwise null field	
14	Differential reference station ID, 0000 – 1023	Value at the EUT if differential mode, otherwise null field (for GPS)	

Table C.2 – Checksum

The checksum of the sentences shall be checked with static and dynamic sentences.

Set condition	Actual condition
Each sentence shall send the correct checksum	

Table C.3 – Example – data string GGA received by the EUT

Field	Field label	Value sent to EUT in the data sentence	Expected value on the EUT	Displayed value on the EUT
1	UTC	121355	No value (Time = Time of fix based on UTC, not to be used as UTC)	
2 + 3	LAT	3433.099,N	34°33.099' N	
		5959.099,S	59°59.099' S	
		Null-Field	No or invalid signed position	
4 + 5	LON	01445.999, E	14°45.999' E	
		17959.999, W	179°59.999' W	
		Null-Field	No or invalid signed position	
6	GPS quality indicator	0	No or invalid signed position	
		1	Send position with label GPS	
		2	Send position with label DGPS	
		3	Send position with label GPS or GPS with PPS	
		any other value	No or invalid signed position	
		2 -> 1	Alarm, send position with label GPS	
		2 -> 0	Alarm, no or invalid signed position	
		2 -> 3	Send position with label GPS	
		3 -> 1	Send position with label GPS	
		1 -> 2	Alarm, send position with label DGPS	
		3 -> 0	Alarm, no or invalid signed position	
		4 – 8 (each value was sent to the EUT)	Send position with the label corresponding to the sent value, an alarm and corresponding label if the value has changed	
		1 -> any other value	Alarm, no or invalid signed position	
		Null field	Alarm, no or invalid signed position	
7	Number of satellites in use, 00 – 12, may be different from the number in view	4	4	
		12	12	
8	Horizontal dilution of precision (HDOP)	1,0	1,0	
		5,5	5,5	
9 + 10	Antenna altitude above/below mean sea level, Units of antenna altitude, m	143,5,M	143,5 m	
		–16,0,M	–16,0 m	
11 + 12	Geoidal separation, Units of geoidal separation, m	43,5,M	43,5 m	
		–20,3,M	–20,3 m	
13	Age of differential GPS data, sec	4	4	
		20	20	
		Null field for GPS	No value	
14	Differential reference station ID, 0000 – 1023	0313	0313	
		0314	0314	
		Null field for GPS	No value	

Table C.4 – Example – Checksum

Send to EUT	Expected value on the EUT	Displayed value on the EUT
Data string GGA with correct checksum	Send position with relevant label	
Data string GGA with incorrect checksum	No or invalid signed position (alarm when the checksum changes from correct to incorrect)	

Table C.5 – Break of data line

Send to EUT	Expected value on the EUT	Displayed value on the EUT
Break of data line during transmission of valid data strings	Alarm after time-out of maximum 30 s, no or invalid signed position	

NOTE Refer to Table C.1 for an example of the range of sentences.

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NOTE 1 All ITU-R/T references developed before 1993 were formerly CCIR/CCITT Recommendations.

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